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FURTHER EDUCATION

BOTH the significance of the further education of young people and adults in Great Britain and the magnitude of the organisational problems which are involved in the creation of a national scheme are emphasized in the Education Act, 1944. The responsibility of local education authorities is clearly defined—"to secure (i) full-time and part-time education for persons over compulsory school age; (ii) leisure-time occupation, in such organised cultural, training and recreative activities as are suited to their requirements, for any persons over compulsory school age who are able and willing to profit by the facilities provided for that purpose". It has, however, become increasingly clear that the discharge of such a responsibility by local education authorities requires more than the provision of teachers, buildings and equipment. Not only does it involve an assessment of the educational needs of the community and presuppose, as the Education Act acknowledges, a close relationship between local education authorities and many local interests; it also implies a change in the functions of these authorities and in their relationship to each other.

So long ago as February 1946, the Ministry of Education accepted the view that "the organisation of further education must be on a regional basis if all the needs of industrial and commercial personnel are to be covered adequately". Efforts have, in the past, been made to solve this difficulty in Yorkshire by the establishment of a Regional Council of Further Education, and in Lancashire, North and South Wales, and the Midlands by similar councils. This trend towards regional co-operation received a new impetus and significance when the Percy Committee on Higher Technological Education recommended that Regional Advisory Councils should be established throughout the country "on the general lines of those now in existence in some areas", and that, "as an integral part of the regional machinery, Regional Councils should create Regional Academic Boards of Technology composed of academic heads of universities and technical colleges and members of their teaching staffs".

Although these recommendations were accepted in principle by the Ministry of Education, there are few signs that the implementation of the report of the Percy Committee is being regarded as a matter of urgency. This is clearly indicated in Circular 133 of the Ministry of Education. In directing local education authorities to prepare and submit their development plans for further education not later than March 31, 1948, the Minister reminds them that they must have regard to facilities for further education provided in their areas by universities, educational associations and other bodies, and to consult such bodies and local education authorities for adjacent areas. It is assumed, adds the Minister, that local education authorities will work in close touch with the regional councils for further education; but, because such councils have *not* been universally established throughout the country, he has been compelled to add that he will require assurance

from some authorities that they have complied with the requirements of the Education Act regarding consultations.

It is therefore not surprising that the Ministry has issued a provocative and suggestive pamphlet* "designed to survey the whole field of further education as an entity, in order both to indicate the part which each feature of it should play in relation to the whole and to suggest possible lines of future development". Still less is it surprising, on account of the tardiness of local education authorities in establishing regional committees, that the emphasis should be upon regional co-operation. Much of it is, indeed, written in elucidation and explanation of the views expressed in Circular 87. On grounds of economy it would be improper, particularly in the higher range of studies, for each local education authority to attempt to provide for all the needs of students living in its area. Nevertheless, economy is not the only factor in regional organisation. There are many positive functions which a regional body can usefully perform; these include the planning of new developments, the expansion of existing facilities, the review of courses and curricula, the most effective use of specialist staff. "To a special degree, our fortunes to-morrow depend upon the extent to which our plans for technical and commercial education are placed to-day in the forefront of our reconstruction programme, and the vigour and vision with which they are carried through."

The deeper significance of the pamphlet lies in the interpretation of this generalization—the conception of further education as an entity. There is the realization that the planning of technical and commercial education is only a part, however important, of a larger task. The immediate responsibility of local education authorities is to assume leadership in the co-operative enterprise of community education; and such education is defined as embracing both skill and social leadership. In addition to possessing the technical knowledge required to meet the highly specialized demands of industry and commerce in a scientific age, men and women must, it is postulated, have an understanding of everyday human relationships. "Industry to-day is a large-scale social organisation and success in it will depend upon qualities of personality no less than upon acquired knowledge." To a very much greater extent than in the past it has, therefore, become necessary to foster corporate life and to extend the range of students' interests and social powers.

Whether, or to what extent, local education authorities will be able to unify work in the field of further education must remain speculative. It should, however, be noted that the Education Sub-Committee of Nuffield College† recently expressed the view that, without seeking to minimize the truly educational work done in technical colleges, philosophy, history, literature and pure science should be recognized as having their own sphere. "'Organised cultural training' is," the statement continues, "in the Education Act put with 'recreative activities' as coming under leisure-time occupation. A further link between these is forged by the Government pamphlet on Community Centres." It is, however, significant that the Ministry has not only organised one department to deal with technical education and "organised cultural training and recreational facilities", but has also indicated to local education authorities that "since, in many areas, the requirements for compulsory part-time education will be within the premises of a single college planned to meet local needs of further education—both compulsory and voluntary—it is essential to regard the requirements of Sections 42 and 43 as part of an integrated whole".

What would, consequently, seem to be indisputable is that local education authorities must, in preparing their plans for further education, give as much consideration to the potentialities of the individual man and woman as to the types of studies and activities to be provided. There are at least two lessons to be learnt from war-time experiences in H.M. Forces. First, the number of people who are ready to take advantage of formal educational activities (other than those which are purely vocational) is relatively small. As Sir Richard Livingstone has said, in paying tribute to the work of the Workers' Educational Association, "it is remarkable until you remember that there are forty-three million people in this island". Secondly, there is reason for believing that a high percentage of the majority who are repulsed by formal education are attracted to informal activities and responsibilities which are shared appropriately among all concerned; and it is of the greatest importance that these men and women should not seek in vain for opportunities to pursue similar interests in civilian life. If the individual is to be socially adequate in a constantly changing world, he requires adaptability and flexibility towards personal and social no less than towards economic and vocational problems.

For this, if for no other reason, it is perhaps fortunate that the difficulties to be overcome are not wholly organisational. Much will obviously depend on the concept of education possessed by those who specialize in work among young people and adults. There are, happily, increasing indications that the compartmental concept of education is being replaced by the integral. In an earlier age educational practice was undoubtedly over-compartmental and, in consequence, society-blind. It either could not see, or failed to admit, the existence of society and the relationship of the individual to it as a relevant factor in human affairs. That it is being replaced by the integral concept is, in large measure, due to the pioneer work which has been done in adult education, the acceptance of the principle that education is a life-long process and the realization that society is, or can become, an educational agent. "The life of Man is," as A. N. Whitehead has written, "founded on technology, science, art and religion;" and it is the ideal of the good educationist to look to the whole man—the good man, the good citizen, and the useful man.

* Further Education. (H.M. Stationery Office.) 2s. net.

† The Further Education of Men and Women: a Task of the 1944 Education Act. (London: Oxford University Press.) 1s. net.

How necessary the acceptance of this ideal has become may be illustrated simply. The achievements of modern technology have been part of a culture of which the central theme has been the seizure and exploitation of power and the increased use of non-human sources of energy. What concentration on the development of this culture has, however, tended to obscure is that, the more energy man commands, the more important it is that this energy should be at the service of his whole personality, and not merely at the command of some narrow ambition or some limited goal. So far as science and technology have been wedded to narrow concepts of human development and human well-being, they have given power to military, political, and financial despots, they have fed their egos and justified their ambitions, they have further brutalized the brutal and corrupted the corrupt. They have, in a variety of ways, disintegrated the life of man by making him the victim of the machine rather than its commander and controller.

Men do not live by machines alone, and the power impulse, however deep and ineradicable, is neither self-sustaining nor self-sufficient. Machines are not—and never can be—a substitute for vital human needs, many of which are frustrated by over-emphasis on the quantitative and mechanical. The hiatus which now exists between those parts of life which have become controlled by machines, and those parts which lie outside their scope, constitutes one of the gravest problems of contemporary society. Nothing less than the autonomy of the human personality is at stake, and it cannot be saved unless the social context in which man has to act and to survive is given adequate attention.

FOSSIL MAN

Les hommes fossiles

Éléments de paléontologie humaine. Par Prof. Marcellin Boule. Troisième édition par Henri V. Vallois. Pp. xii + 587. (Paris: Masson et Cie., 1946.) 1200 francs.

SINCE it first appeared a quarter of a century ago, Boule's treatise on fossil man has become one of the recognized classics of human palæontology. It has been particularly noted for the clarity of its exposition and for its very fair summarization of the sort of evidence (often sparse and difficult to interpret) upon which palæontologists have to rely. It was primarily also a personal exposition, reflecting the results of the author's original observations and his own assessment of the evidence presented by others. Between 1934 and 1939, Boule worked on the revision of his book for a third edition, and during this time had completed the first eight chapters (that is, more than half the volume). It had been his intention to complete the revision on his retirement; but the outbreak of war and his death soon afterwards prevented this. However, the task has been undertaken by his colleague, Prof. Vallois, than whom no better qualified editor could probably be found.

No doubt the main difficulty of the editor must have been to give adequate expression to the wealth of new discoveries bearing on prehistoric man which have been made during the last few years. But Prof. Vallois has taken the wise course of retaining the individuality of Boule's classic book even at the risk of leaving it somewhat unbalanced as a representative account all the additional evidence relating to the evolution of *Homo sapiens* which has quite lately become available. On the other hand, all the most recent evidence is included by reference, even though in some cases it may not be treated in the detail which its importance might seem to require.

Boule's was clearly a 'master mind' in the sense that he had an intimate knowledge of details and at the same time a really comprehensive grasp of the subject of human palæontology as a whole, and it is worth while considering his main conclusions concerning some of the more obscure problems which still provoke controversy.

As regards 'tertiary man', in so far as the solution of this problem depends on eoliths the author expresses himself with extreme caution. He definitely rejects the evidence which was presented so forcibly by Ray Lankester and Reid Moir, and in regard to other evidence he concludes that we have no infallible means of distinguishing the fortuitous natural chipping of 'eoliths' from the products of an intentional handiwork which in any event was extremely crude. The osteological evidence provided by all the *Pithecanthropus* material now available from Java, and also the remains of Pekin man, is considered at length, with the general conclusion that they should be grouped together as "Préhominiens", indicating their ancestral relationship to Neanderthal and modern types of man. The author emphasizes very strongly the close relationship of the Javanese and Pekin fossils, and insists that the differences between them have at most a specific (and certainly not a generic) value. This conclusion is in full accord with the view now commonly adopted by palæontologists that the original nomenclature of Davidson Black, *Sinanthropus pekinensis*, should be replaced by *Pithecanthropus pekinensis*.

The discussion of Neanderthal man occupies a relatively large portion of the book, as might be expected from a consideration of Boule's classical study of the almost complete skeleton found at La Chapelle aux Saints in 1908. The view is taken that *Homo Neanderthalensis* was essentially a specialized and somewhat aberrant form which became extinct and played no part in the evolutionary development of *Homo sapiens*. This interpretation also now receives wide accord, and, indeed, it could scarcely be otherwise since the accumulation of evidence provided by the Ehringsdorf, Steinheim and Swanscombe skulls, to say nothing of other evidence (including that from East Africa) which indicates the existence of *Homo sapiens* in pre-Mousterian times. The negroid affinities of the Aurignacian skeletons from Grimaldi are accepted; but the strong arguments which have been adduced for the Eskimoid nature of the Magdalenian skeleton of Chancelade are vigorously contested. Lastly, Cro-Magnon Man is believed to survive still in parts of the Dordogne and in the population of the Canary Islands.

A phase of human palæontology which receives inadequate treatment is that represented by the now famous Australopithecine fossils of South Africa. These important discoveries are quite cursorily dealt with in scarcely more than three pages and, although it is conceded that they are the most human of fossil apes which have so far been discovered, they are given no particular place in the theme of human evolution. Had Boule lived long

enough to learn the mass of evidence regarding these remarkable fossils which has accumulated during the last few years, and particularly if he had been able to read the monographic study on the Australopithecinæ recently published by Dr. Robert Broom, there is little doubt that he would have recognized their importance by devoting much more space to their consideration.

An interesting feature of this new edition is the fact that more than 130 pages are now occupied with discussions of the remains of fossil man and his cultures which have been discovered in other parts of the world besides Europe—India, Malaya, Oceania, Australia, Africa, North America and South America. This is interesting as an indication of the increasing attention which is being directed to archæological research outside Europe. It may be surmised that in a future edition the geographical balance will be altered still further, for it is becoming more and more clear (particularly as the result of recent discoveries in the African continent) that the early palæolithic populations in Europe may have been little more than the 'stragglers' of much larger and more highly organised communities which were responsible for developing the characteristic palæolithic cultures in parts of the world less disturbed by gross climatic fluctuations. It is perhaps scarcely necessary to add, of a book so well known in its previous edition, that the illustrations are both excellent and numerous. W. E. Le Gros Clark

BIOLOGY OF CARCINOGENESIS BY CHEMICAL COMPOUNDS

Les cancers produits par des substances chimiques exogènes

Par Prof. Antoine Lacassagne. (Radiophysiologie expérimentale cancer et hormones, 5: Actualités scientifiques et industrielles, 1003.) Pp. 166. (Paris: Masson et Cie., 1946.) 150 francs.

THIS monograph by Prof. Lacassagne is one of a group which will cover the subject of carcinogenesis and deals with the production of cancer by chemical substances. In the first chapter the author discusses arsenical cancer. Arsenites were indicted as carcinogenic agents so long ago as 1820, but no unequivocal evidence has ever been produced to show that arsenic is carcinogenic. No reference is made to Prof. E. L. Kennaway's discussion of this part of the subject under the title of "A Contribution to the Mythology of Cancer Research" (*Lancet*, **2**, 769; 1942); but this paper may not have been available in Paris when the monograph was written. Although arsenites have not been shown to be carcinogenic in experiments on animals, they are mitotic inhibitors belonging to the class of radiomimetic poisons which also includes some of the vesicants. The relation between mitotic poisons and carcinogens is still obscure, but urethane is a carcinogen which inhibits mitosis.

The second group of substances considered are the nitrogen-containing polycyclic compounds which have been of interest since 1906, when it was shown that cancer of the bladder occurred abnormally frequently in workers handling fuchsine and naphthylamine. Cancer of the bladder has been induced experimentally in animals by three substances: β-naphthylamine, *o*-aminoazotoluene and 2-acetylaminofluorene. Some aromatic nitrogen compounds such as 2 : 2′-azonaphthalene, 2 : 2′-diamino-1 : 1′-dinaphthyl and 4-dimethylaminoazobenzene are able to induce cancer of the liver. The action of this type of compound on the liver is dependent upon the diet on which the experimental animals are maintained, the incidence of cancer of the liver being much higher in animals maintained on 'poor' or low protein diets. This may be connected with the high incidence of cancer of the liver in communities such as the Bantus and Japanese, where low protein dietaries are common. The author points out how the compound Styryl 430 is unique in being a water-soluble aromatic carcinogenic compound. Finally, the nitrogenous carcinogens include substances resembling the carcinogenic hydrocarbons in which a carbon atom is replaced by nitrogen as in the benzacridines and dibenzcarbazoles. One of these, 3 : 4 : 5 : 6-dibenzcarbazole, forms a link in that it is capable of producing tumours at the site of application as the hydrocarbons do, and also producing cancer of the liver like many aromatic amines.

The last hundred pages of the book are devoted to the carcinogenic hydrocarbons from the point of view of a biologist rather than from that of a chemist, as the chemistry of carcinogenesis will be discussed in a separate volume by Prof. N. P. Buu-Hoï. The general rules relating carcinogenic activity and chemical structure are indicated, but the emphasis is on the history of the subject and the biological experiments. Advances in our knowledge of biological actions are often dependent on methods of testing. Methods for testing carcinogenic activity were first developed in Japan, but used to great effect by European workers, particularly by research workers at the Royal Cancer Hospital, London. A carcinogenic substance was isolated from coal tar, and a large number of synthetic hydrocarbons shown to be able to produce cancer on the skin of mice. Coal tar is usually too toxic to be used for injection into the body, but the preparation of pure carcinogenic hydrocarbons made it possible to produce cancer of many organs in different species of animals. Prof. Lacassagne refers to injection as "la méthode américaine", in contrast to painting the skin with the carcinogenic substance or "la méthode anglaise".

Experiments carried out in many laboratories have shown that tissues and species of animals differ widely in their susceptibility to carcinogenic substances. The epidermal and connective tissues are the most sensitive, and the alimentary tract is relatively resistant. Tumours have been induced by carcinogenic hydrocarbons in mammary glands, testes, kidney, liver, prostate, brain, lung, salivary glands and connective tissue. A separate chapter is devoted to the induction of tumours of the alimentary tract and of the lung. These two sites are of great importance from the point of view of human cancer, but attempts to produce tumours of the stomach or lung in animals by hydrocarbons have given most erratic results. The tumours of the stomach which have been induced in mice are not comparable with gastric cancer in man. This is a part of the subject which requires much more investigation before the carcinogenic process is understood. The application of carcinogens to the blood-forming organs either directly or by injection of circulating carcinogenic substances leads to leucæmic changes which may be malignant and vary enormously in type.

The whole review, written by a leading worker in the field, forms an interesting discussion of the effects in different species and in animals of different genetic constitution, of carcinogenic substances in various media administered by divers routes. E. Boyland

Racial Pride and Prejudice

By Eric John Dingwall. Pp. x + 246. (London: Watts and Co., Ltd., 1946.) 8s. 6d. net.

THIS book deals with an important world problem from the point of view of the anthropologist and the psychologist. It is intended for the general reader rather than the student of either of these sciences, and Dr. Dingwall is to be congratulated on the way he has managed to avoid technical language except where it is absolutely necessary. The book has another great advantage in that the author is not only content to present the facts as he sees them, but also does not hesitate to insert short discussions of the possible reasons that lie behind customs and legislation associated with the colour bar. The combined presentation makes admirable reading. It is unnecessary in a notice of this character to stress the sane, but nevertheless realistic, point of view of the author; it would be more appropriate to direct attention to other special merits that the book possesses. One of these is the admirable psychological approach to the problem of prejudices in general and colour prejudice in particular, and Chapter 14 on the psychology of racial and colour prejudice is a masterful essay in itself. The reader is impressed particularly by the part that jealousy plays in this respect.

To the geography student the book has yet another distinct advantage in so far that the treatment is global. There are chapters on the colour bar in the United States of America, Great Britain, Africa, the West Indies, India and the East, Brazil, Australia and New Zealand, and the U.S.S.R. Such a complete world survey is admirable and will be much appreciated by the student of human geography. The author states in his preface that references and footnotes have been cut down so far as is possible in a book of this kind, and that if authority were to be quoted for every statement the bulk of the book would be almost double and its value would not have been increased in proportion. Nevertheless, the addition of a few well-selected maps showing, for example, the distribution of the Negro population in the United States, or the white population in the Union of South Africa, would be most welcome. The general reader, for whom this volume was written, is ignorant of these essential facts, and while the addition of a few distribution maps would not have made the volume more bulky, it would have increased its value very considerably. E. G. BOWEN

Introductory College Chemistry

By Prof. Harry N. Holmes. Fourth edition. Pp. x+590. (New York: The Macmillan Company; London: Macmillan and Co., Ltd., 1946.) 18s. net.

THIS very attractive book is now in a fourth edition and has been considerably revised. Although its title, and the statement in the preface that it "is of full college grade", suggest a moderately advanced book, it is really of a standard that would be used in schools in England, and in many parts does not reach Higher School Certificate level. The charts and illustrations are often suitable only for very immature students.

The sections on the metals are dispersed, group methods of preparation and group reactions being stressed. The physical chemistry is presented in some detail, and there are whole chapters on the structure of the atom and nuclear chemistry. Chapters on organic chemistry include matters of technical interest or of importance in daily life, such as hydrocarbons, rubber, carbohydrates, plastics, and food and nutrition. There are references to literature (including some English journals) and questions. In many cases the information is very slight: the only property of carbon disulphide (which has five lines of text) mentioned being that "one pound is needed in the manufacture of three pounds of viscose rayon". The sections on selenium and tellurium, on the other hand, extend over nearly two pages. The validity of the formulæ of orthonitric acid on p. 303, with 5-valent nitrogen, is doubtful. Mercurous compounds are formulated with univalent mercury. These are minor points; generally the text is very clear and accurate.

What will interest most readers is the very large number of out-of-the-way and striking facts which are worked into the text; teachers should find many of these likely to stimulate interest. Although the book is not suitable for English school courses, and is much too elementary for junior university use, it is one which can be recommended as likely to be popular in a school library and useful to the teacher. The production is excellent and the price, although rather high for its size, is not prohibitive.

The Scottish Railway Network

A Project for Reconstructing the Scottish Railways according to certain New Railway Network Principles. By J. F. Pownall. Pp. 72. (Birmingham: Cotterell and Co., 1946.) 8s. 6d.

IN this small volume Mr. Pownall returns to an exposition of his hour section principle which he outlined in his "New Railway Network Principles". The present volume deals with Scottish railways. The central idea is that full value cannot be derived from most railway lines because, in spite of good speeds, continuity of movement is hampered. The author would ensure fast journeys on the trunk lines, and the more important branch lines, by recognizing certain "hour stations" on all important routes. Some of these would be stations of present importance to-day, others of little importance and others new stations. Expresses would call at these stations and these only, at precise hour intervals, and connect with slower intermediate trains. Several new lines would be necessary. The scheme is ingenious and deserves consideration in any plans for the modernization of the railways of Great Britain.

The Faroes in Pictures

By Gordon Huson. Pp. 82. (London: George Allen and Unwin, Ltd., 1946.) 10s. net.

THE Faroes are little more than a group of huge volcanic rocks reaching to heights of several thousand feet above sea-level. They lie on the Faroe-Icelandic ridge 200 miles from the nearest land, which is Scotland. Rainy, windswept and infertile though the islands are, their growing population numbers nearly thirty thousand and is fairly homogeneous of early Norse descent. Only three per cent of the land area is cultivated, and most of that is used for sheep grazing. The main occupations are fishing and whaling. The comparatively small caaing or grind whale is caught in numbers. Little in English has been written on these Danish islands. The exigencies of war led to a British garrison, and Major Huson, who was in that garrison, has produced a charming and useful book of pictures to which is attached a very brief account of the islands. The pictures give an excellent idea of the land forms and the surface conditions.

THE LATE-GLACIAL PERIOD

By P. TALLANTIRE and S. M. WALTERS
Botany School, Cambridge

A DISCUSSION on "The Survival and Extinction of Flora and Fauna in Glacial and Post-glacial Times: the Problem Viewed in Relation to Quaternary Historical Investigations" was held by the British Ecological Society at a meeting in the rooms of the Royal Society on October 15, 1946. The president of the Society, Dr. A. S. Watt, pointed out that it was eleven and a half years since the same rooms had witnessed the Royal Society discussion on the "Origin and Relationships of the British Flora". Although there were a number of contributions from pollen analysts in the original discussion, the emphasis had now shifted towards the lines of evidence that they could supply. This meeting was one of a number then being held in connexion with a conference for Quaternary history in north-western Europe.

The first speaker, Prof. K. Jessen, of Copenhagen, said that in previous discussions, as for example at the Royal Society in 1935, all shades of opinion had been represented, from 100 per cent extinction of the British flora and fauna at maximum glaciation, with subsequent immigration, to 100 per cent survival. The real need was for reliable evidence based on actual, macroscopic remains of the plants and animals in question, particularly thermophiles, in glacial and late-glacial deposits. These evidences are few at present, and somewhat idle speculation correspondingly excessive. He gave a résumé, with slide illustrations, of the probable course of the late-glacial vegetational development in north-west Europe, and possible climatic inferences. Commencing with his three late-glacial periods: I. Older *Salix*; II. Allerød; III. Younger *Salix* time: distinguishable in Denmark, north-west Germany, and Ireland, he tentatively equated the Younger *Salix* period with the formation of the Salpausselka moraine stage of the Scandinavian ice-retreat. Subsequent developments were considered to be post-glacial.

A distribution map for period II showed 'tundra' in North Denmark, 'park tundra' to the south, and the northern border of pine and birch forests in South Baltic regions. In Ireland there was 'tundra' over most areas, possibly *Empetrum* heath in the north and north-west. The forest northern border definitely lay well south of Ireland, but so far its position was unknown for England and Wales. He stressed the difficulties of characterizing the vegetation zones by names, since the conceptions, for example, 'tundra', varied considerably in different regions. 'Park tundra' was intended to connote a tundra vegetation with patches of bare moraine, patches of dwarf salices, *Betula nana*, *Dryas octopetala*, etc., and occasional copses of larger birch species in favourable localities. In Zone III certainly no woods were suggested, as evidenced both by the absence of macroscopic remains of tree-birch, there being only one certain locality for this type of birch in Ireland in the Younger *Salix* period.

Late-glacial sea-levels were known to have been as much as two hundred metres lower than present ones, so that former land-connexions, for example, England to Ireland, Ireland to Spain, and the former southward extension of land in the Solent region in England, may have existed and may possibly have borne forests, for example, of *Arbutus*, in an oceanic wood flora to the west of Cornwall, as has been suggested (by Du Rietz).

The difference between vegetational development in Ireland and in Denmark was considered due, then as now, to more oceanic climatic influences in the west. The pattern of post-glacial development is parallel in the two countries. In the first post-glacial zone, Zone IV of Jessen, birch (*Betula pubescens*, agg.) enters in large amount and has an over-all dominance; pine is very insignificant both in the pollen curves and macroscopically. Large willow species are frequent. At the same time, there is an immigration of thermophile aquatic species in both countries, for example, *Ceratophyllum demersum*. In Zone V, with birch dominance and a spread of hazel, there occurs the first certain evidence for pine, although still in small amounts. In Zone VI*a*, with an astounding hazel preponderance, the two species of *Naias* appear in Ireland, having been present in Denmark in Zone V as well; *Naias marina* represented in a few localities, *N. flexilis* in slightly more. The hazel maximum phenomenon, with traces of mixed oak forest (*Quercus* + *Tilia* + *Ulmus*), is observable all over north-western Europe. Its meaning or contemporaneity are both so far unknown. Uncertain, too, is the pine maximum, in the Boreal Zone VI*b* in the west of Ireland but delayed until VI*c* in the north-east.

Since *Naias flexilis* occurs in Ireland at the present day, its presence in Zone VI may indicate that it is a survival species, at least, that is, indigenous and not re-introduced by human agency. A similar point was made for *Eriocaulon septangulare*, the pollen of which is found in Zone VII*a* at Roundstone, a present-day west Ireland locality as well. Three *Erica* species occur in the Roundstone deposits—the Atlantic species *E. cinerea* from Zones V and VI, *E. tetralix* from Zones V–VII*a*, and one of the Lusitanian species, *Erica Mackaii*, macroscopically identified from leaves, from Zones VI and VII*a* and from inter-glacial deposits in the west of Ireland. The present distribution of *E. Mackaii* is Portugal, north Spain, and a few localities in western Ireland apparently as in Boreal times. It is absent from France.

Dr. Jessen concluded by saying that survival and subsequent immigration of species in Denmark was believed to have centred on south-east and south-west Europe. The speed of immigration had been no quicker in Ireland, thus it seemed unlikely that the Irish species survived so close to Ireland as the debatable southern land surface towards the Bay of Biscay.

Dr. J. Iversen, of the Danish Geological Survey, spoke next on some steppe elements in the Danish late-glacial flora and fauna. The first indications of such an element were encountered in the 1800's when Steenstrup described the ground squirrel (*Spermophilus rufescens*) in a late-glacial freshwater deposit. More recently plant evidence has come to light, and other faunal remains can be roughly dated by pollen analysis methods. Late-glacial finds, in the so-called reindeer period, comprise surprisingly few 'arctic' forms, including only a skull of a mouse hare (*Lepus timidus*) and a jaw of the glutton. Even these, together with the reindeer, are not solely restricted to an arctic–alpine range but may penetrate the forest belt. Steppe forms have an equal frequency. Time and distribution maps were shown for the bison and wild horse from late-glacial

and preboreal periods, one find each of the ground-squirrel and mouse have been made from the late-glacial, and four finds of the Irish giant deer dating from the late-glacial and early Allerød. The latter may represent a third, woodland, element restricted to the milder Allerød and post-glacial periods in Denmark. Similarly in north-west Germany, at Ahrendsburg and Meiendorf, bones of the wild horse are reported from the late-glacial stages of the deposits. The plant indices are the high frequencies of *Artemisia* and *Hippophæ* pollen from late-glacial maxima of non-tree-pollen. Presence of *Hippophæ* is proved by finds of the peltate scales. Another index, a species of *Helianthemum*, now found in Central European mountains but not in Scandinavian mountain regions, is frequent among late-glacial pollen samples. If on retreat of the ice from Denmark the tundra belt disappeared and forests extended practically to the ice margins, then suitable habitats for steppe elements would disappear and no subsequent immigration prove possible, since "the forest is inimical to both arctic and steppe elements". The mixed 'tundra' and 'steppe' flora and fauna probably existed in the belt of 'park tundra', rich in grasses and herbs, of up to a hundred kilometres wide as envisaged by Jessen. This zone and the associated fauna disappeared when post-glacial forest invasion commenced, only the bison and the wild horse lingering until the Maglemosean era in Denmark.

Prof. K. Faegri, of Bergen Museum, dealt with the position of *Hippophæ rhamnoides* in Norway, which in north Europe is restricted to the shores of the Baltic, the north Norwegian and south Danish coasts. Elsewhere in the 'regio alpina media' in Asia, and to sea-level in Scandinavia, it shows a fair degree of tolerance though with some preference for calcareous soil. The fossil distribution appears to have been wide in late-glacial times. A scarcity of localities from Norway is probably due to a scarcity of investigations. Knowledge of ecology suggests that its disappearance is unlikely to have been due to temperature changes. Competition, or the lack of it, or soil leaching are more likely factors, as is indicated by present distribution on regions of coastal uplift, that is, where new ground is continually present and where *Hippophæ* acts as a pioneer species and so maintains itself. The one or two inland stations recorded are similarly on friable calcareous cliffs where rockfalls keep the habitat open. It may be that until the post-glacial forests closed in there existed habitats of suitable open ground or with minimal competition in the shrub layer.

Dr. F. Mitchell, of Dublin, described discoveries in Ireland of remains of the giant Irish deer and reindeer. Recent work in Ireland on 'zoned' plant beds in relation to glacial deposits has led to a modification of Charlesworth's views of the distribution of the Newer Drift as shown in his map of 1929. This is the separation of the mountain glaciation phase in Ireland, principally of the Wicklow Mountains (and perhaps correspondingly, therefore, in the Welsh Mountains), as of a later date than the Newer Drift. The Scottish Re-advance may well date from this phase as well. In the lowlands solifluxion deposits were formed during the period of Jessen's Zone III. Two distribution maps were shown, one for late-glacial deposits, and localities with finds of giant Irish deer actually found embedded in such deposits, the other constructed for finds recorded in the literature, whether supported by reliable field evidence or not, of reindeer finds from open country sites (finds from limestone caves being neglected). There is a frequent association of reindeer bones with those of the giant deer, for example, at Ballybetagh.

In localities surrounded by steeper and better drained slopes the solifluxion layer may contain such arctic plants as *Armeria* (?*arctica*), *Dryas octopetala* and *Oxyria digyna*. The distribution of the two large mammals tends to be general except for a lack in the north and north-west. This compares with Jessen's recognition of tundra or open willow and juniper woods over most of Ireland, and *Empetrum* heaths in the north-west in the Allerød period; the former areas being grassier and thus possibly preferred by reindeer. The Allerød period appears to have been the period when the giant deer flourished; later finds of it are of dubious validity. One from the region to the north of the conjectural ice limit of the Scottish re-advance stage in Ulster, if confirmed, raises the problem of the contemporaneity of the Scottish and Wicklow mountain glaciations and the question of whether the fauna survived, however meagrely, into early post-glacial times. Probably extinction occurred, more or less completely, in the rigorous tundra phase after the Allerød period.

Dr. K. B. Blackburn, King's College, Newcastle, described two anomalous finds, one of *Trapa natans* in the Scottish Outer Isles, and one of the moose (*Alces Alces*) in the Tees Valley at Neasham. All they have in common is that both are now extinct in Britain, while both were present together in Cromer Forest Bed times.

The fossil *Trapa* nut was found entangled in floating *Potamogeton* debris in a loch in South Uist. The loch is brackish and connects to the sea-loch, Loch Eynort, by a tide-race 10 ft. wide and about 50–100 yd. long. The nut was dated by obtaining a pollen sample from adhering peat. 140 tree-pollen grains and some non-tree-pollens were obtained, and the spectrum constructed from them was matched with the longest peat profile diagram so far obtained in the neighbouring regions. The spectrum appeared to agree with a level about mid-Zone VII of the tentative zoning of the diagram. The two profiles, Stoneybridge and Calvay, both have an *Alnus* rise at the base which might be equated with the Zone VI–Zone VII transition to Atlantic times. The nut is assumed to be indigenous, since *Selaginella* and *Drosera* pollen occurred on the nut as in the Zone VII, and other zones of the diagrams, and, it may be added, in the local vegetation at present. No pollens were found on the nut that were not represented from the diagrams, and this also suggested that the nut had not been washed up Loch Eynort into Loch Ceann-a-bhaigh from the sea. A European distribution map for *Trapa* was shown.

The moose skeleton at Neasham fell out of a peaty band halfway up a brickpit face. This band is inferred to be a deep-water lake-mud. The sequence of deposits was as follows:

3. Clay.

2. Upper peat.
   Slightly laminated clay (locally known as 'prismatic' clay and generally considered to be a water-lain deposit).
   Lower peat—Hypnum above, laminated below (thinner towards side of section).

1. Clay.

In Raistrick's map of the distribution of late-glacial lakes ponded by the Cheviot Ice, one lake is shown over the Neasham district. A pollen diagram was made for the section. The lower peat shows high values for pine basally followed by high birch and willow and a reversion to high pine at the top. There is an increase in the alder curve in the upper peat which may mark the start of Zone VII. The central part, in which the moose was found, may be late-glacial; but the presence of high hazel values at the same level needs accounting for if the clay above is to be suggested as belonging to Zone III, and such correlations are scarcely justified at this stage. The present range of the moose includes the forested lake country of northern Canada.

Prof. Heslop Harrison's paper was read, in his absence, by Prof. Clapham. There are four elements concerned. The 'American' group of species such as *Spiranthes stricta*, *Eriocaulon*, *Sisyrynchium*, *Naias flexilis*, and the sponge *Heteromyelia Rylei*. This group is largely centred on the group of islands between the Outer and Inner Hebrides, Coll, Tiree, and Gunna, particularly the first-named. Secondly, the so-called 'Macaronesian' element including the moss *Myurium hebridarum*, which occurs in the Outer Isles in places, Coll, Tiree, and Eigg, in a non-fruiting state, its principal centre being the Canary Islands and the Azores. Another in this element is the water-beetle *Deronectes canariensis*. Thirdly, there is the development of the distinct Hebridean races of plants and animals common on the mainland, for example, wren, thrush and field-mouse and many insects; such plants as *Orchis hebridensis*, *Lonicera*, *Pericylmenum* var. *Clarkii*, *Rosa* spp. The fourth element is that of the arctic alpines.

All the problems have to be reviewed in relation to what is known, as yet, of the geological and geographical history of the whole group of islands during glacial and late-glacial times. There has been too much speculation about these regions up to the present, based on erroneous information or none.

Jehu and Craig considered some time ago the upper slopes, above 1,500 ft., of Bheinn Mohr in South Uist, to be unglaciated. The many changes of sea-level in glacial, late- and post-glacial times presume certain linkages and separations of the various island groups one with another, and with the mainland and Ireland. As regards such islands as Coll and Tiree, a not very extensive rise in former sea-level, for example, to the 100 ft. beach-level perhaps, would have been sufficient to submerge them completely, with consequent extinction of the flora and fauna. Similar extinction can be presumed for those islands that were completely glaciated at maximum or subsequent glaciations. Prof. Harrison openly admitted, however, that he has approached the problems with a bias towards a 100 per cent survival of flora and fauna. Pre-glacial raised beaches suggest the Hebrides to have been islands at the start of the Ice Age, presumably possessing a small flora representative of the rest of the mainland. To what extent this was overwhelmed, survived on nunataks, or migrated and afterwards immigrated, depends on glacial conditions at their maximum for each area. On Bheinn Mhor, South Uist, we find such plants as *Saxifraga stellaris*, *Sedum roseum*, *Oxryia digyna*, *Alopecurus alpinus* (this last nowhere else save on the mainland), *Silene acaulis*, *Carex capitata*, *C. bicolor*, *C. glacialis*, *Poa alpina*, *Arenaria gothica*, *Saussurea alpina*, and the mosses *Andræa vittii*, *Ditrichum vaginans*, and *Myurium hebridarum*. Can we credit persistence of these plants here, and on mountains of similar heights in this and other islands, on ice-free ledges of high cliffs and nunataks, or possibly on land surfaces exposed by eustatic fall in sea-level? There is little glacial drift west of the exposed mountains on the Long Island, which may have been ice-free. Among faunal survivals are *Bombus* spp., *Salices*, the associated *Pontalia* and mites, and many spiders.

If the islands were cut off from the mainland after the last inter-glacial by an ice barrier, with no subsequent land connexion, we might account for the development of the Hebridean races. A previous connexion with the mainland during inter-glacial iso- and eu-static adjustments, allowing immigration to occur in the cases of those islands the floras and faunas of which had been overwhelmed at maximum glaciation previously, could be postulated. All this is hypothetical at the present state of our knowledge. *Campylopus Shoreii* and *Rubus* species may have immigrated with the Eu-Hebridean races and survived with them. Where the American element, absent from the Outer Isles, survived is a problem. Possibly on some ice-free area to the west of Ireland; the presence of *Eriocaulon* in inter-glacial deposits in the west of Ireland may be cited as indicative evidence. Presence before and after a glaciation without knowledge of other factors is not necessarily *a priori* evidence for survival, however, and the number of investigations of late- or inter-glacial deposits in the Western Isles is very small as yet.

The richness of the flora and fauna of the Inner Isles, in part, compared with that of the Outer Isles, was explained by assuming progressive west to east severance of land connexions. The Coll, Tiree group being cut off later, there was more time available for immigration.

Prof. Zeuner raised the question as to what evidence the geologist can supply towards reconstructing the ecological conditions during late-glacial times. The distribution of fossil soils shows a preponderance of solifluxion phenomena in the west, especially from the south of England and France, but east of the Rhine a dominance of loess types. With solifluxion on a frozen subsoil there may have been taiga conditions such as prevail to-day in Siberia. In the loess areas grass-steppe conditions with an absence of trees, except in the river valley bottoms, where the loess itself appears to be absent, may be conjectured. Between the loess and the Scandinavian ice there was a 10–100-km. wide belt, presumably of a tundra type, but differing from modern arctic types in its meteorological conditions. The radiation was possibly the same as that to-day for these latitudes, thus a richer flora and fauna may have been possible. The loess conditions disappeared after the Salpausselka stage, climate ameliorated, and the forest belt advanced northwards. Dr. Zeuner is opposed to the survivalists' theory of the Mediterranean and Lusitanian elements in Ireland and Scotland since the existence of the hypothetical land area between Ireland and Spain had never been proved, and he thought that to-day these forms just survived and could not have withstood the rigour of glacial conditions.

Mr. Wilmott assured the meeting that Lusitanian species do not merely just survive in Britain but also flourish from the mountains down to sea-level, although they may be ecotypes of species the southern forms of which could not survive. He cited an instance from a recent cold winter in which Irish forms of *Saxifraga umbrosa* in his garden survived but the Pyrenean forms were killed. He warned

foreigners that in Britain they were dealing with the Atlantic climate, which could play many tricks. The Hebrides and Caithness are treeless, but this condition is governed by high winds and lack of snow cover in winter, not of temperature, and there is no tundra there. What degree of coldness did the presence of ice here really indicate? He pointed out a similarity of British and Finnish floras even to-day.

Mr. C. Elton said that from a zoological point of view the Outer Isles, Shetlands, Isle of Man, etc., appear to have been separated from the rest of Britain since the last inter-glacial, since they lack so many of the species common to the main island. Although the post-glacial vegetational history of Ireland seemed to imply a land connexion in the Holocene, this was inconceivable on zoological and geological grounds. Did man play a more important part than we have imagined up to the present?

Prof. Jessen, replying to previous speakers, reaffirmed that Ireland in the late-glacial lay to the north of the forest limit. Whether 'tundra', or whatever else it might be called, it was treeless. *Arbutus* could scarcely have survived on a land surface between Ireland and Spain for, if it did exist, it must have been very oceanic and subject to high winds. *Arbutus* is a shelter-demanding species. Boreal species might have survived on nunatak areas in the south of England, but doubtfully Lusitanian species. The present distribution of *Trapa natans* is very sharply defined in the north-west of Europe to-day, in regions of Continental warm summers but immaterial winter conditions. He doubted if the 18° C. July isotherm ever existed in the Hebrides region in post-glacial times.

Dr. J. B. Simpson, who surveyed Coll and Tiree for the Geological Survey of Great Britain, was certain that they were completely glaciated at maximum glaciation. Glacial striæ occurred all over these islands at all heights. He wondered if human agency during the Viking period was responsible for any plant introductions. The Outer Isles were regular ports of call for galleys plying between Ireland and Iceland. Further, bird migrants, such as the shearwater, which goes south to the Canaries, might have influenced moss dispersal.

Prof. Faegri was somewhat against a Viking dispersal agency, as many of the species concerned, for example, *Arenaria norvegica*, *Carex bicolor*, were extremely rare even in Norway.

Dr. Farrington appealed to botanists to lay aside their speculations and instead seek to establish a reliable geological background for the phenomena of floral history. If the Welsh mountain ice proved to have been pushed about by Northern ice, then it must be earlier than the Wicklow Mountain glaciation. This was considered later than any major ice sheet in Ireland. If varying onsets were established for the different regions, the whole problem of the contemporaneity, at present assumed, was thrown into doubt. If the last glaciation was later than that in Denmark there was no discrepancy in the time for immigration of the floras to be explained. He stressed that the problem of contemporaneity of immigration assumes similar glacial and climatic developments in Ireland and in Denmark. There are good reasons for thinking that this is far from being the case and that local mountain glaciations occurred later in Ireland. During the Daniglacial and Gotiglacial stages it appears likely that there was a retreating ice margin in Scandinavia, but after the Salpausselka moraine stage the retreat was far more one of the decay of stagnant ice *in situ*. The Irish conditions are not yet clear. He asked, was the so-called Allerød oscillation contemporaneous or a stage in glacial retreat?

Prof. Flörschutz (Holland) stated that *Trapa natans* was known from the primary and secondary inter-glacials and from Atlantic times, as a fossil, in Holland.

Dr. E. S. Brown contributed information on insect faunas in the Faroe Islands. In a certain species of Tipulid (cranefly), *T. pagana*, the females were wingless and therefore could not migrate by flight. Assuming the Faroes to have been islands since late-glacial times, how had this species colonized them? Bird migration was an unlikely factor since the Tipulid eggs were produced in autumn when the birds were migrating southwards. Human dispersal by boat was also considered unlikely. On many different islands in the group, up to forty miles apart, another species occurred the females of which were practically wingless and in the same position, as regards migration, as *T. pagana*. Transport in hay was later suggested as a factor.

Dr. P. W. Richards suggested that Bryophytes may well prove valuable in the study of these problems. The British flora is particularly rich in relict species, for example, the liverworts, *Mastigophora Woodsii* and *Scapania nimbosa*, restricted to the Hebrides, Western Ireland and Western Scotland, and the moss, *Myurium hebridarum*, are probably pre-glacial relicts. None of these shows spore reproduction in its present station, except *Myurium* in the Canary Islands, and none has any means of vegetative reproduction. He considered bird dispersal of Bryophytes to be very improbable. Attention was directed to a British–Chinese element represented by *Mastigophora* with a disjunct distribution in Eastern Asia and the Hebrides. This is comparable to the Chinese–American flora, with only fossil representatives in Europe, for example, *Magnolia*. He suggested that Bryophyte representatives of these floras, with their small size and great tolerance of unfavourable conditions, might well have survived as relict species to-day. Prof. Jessen's conclusions on the oceanic nature of the late-glacial climate in Ireland were noteworthy. Such species of the arctic–alpine group, for example, *Paludella squarrosa*, with a relict southern distribution but fairly frequent in the north until drainage operations have caused it lately to diminish, has a very poor representation in Ireland. Could this be due to there never having been suitable conditions there for its establishment after glacial times?

Dr. W. A. Clarke pointed out that the flora of Rhum stands somewhat apart from that of neighbouring islands, possibly due to the higher mountains, reproducing the non-glaciated upper slope conditions of Bhienn Mhor group, South Uist. Such plants as *Poa alpina*, *Saussurea alpina*, *Thlaspi alpestre*, and *Arenaria norvegica* are present in some quantity at only 1,500 ft. The nature of the summits and ridges with angular non-glaciated, but excessively frost-shattered, debris recalls Fernald's mountain top survival sites in Newfoundland. The moss *Myurium* is frequent up to the summit of Bheinn Mhor, South Uist, though the several expeditions to the Clisham area in Harris have not found it there also. He suggested that its lowlands stations were colonized afresh, after survival in the mountain regions, namely, *Myurium* on Ben na Hoe sea cliff, South Uist, mentioned by Prof. Harrison.

SCIENCE IN ADULT EDUCATION

By Dr. M. H. CLIFFORD

Board of Extra-Mural Studies, University of Cambridge

DURING 1946, full-time appointments of tutors to give extra-mural instruction in the natural sciences were made both by the University of Birmingham and by the University of Cambridge. The inclusion of natural scientists in the staffs of extra-mural departments is a development which reflects the increasing recognition of the importance of, and the growing demand for, the teaching of science to adults.

The Education Act of 1944 has charged local authorities with the duty of securing for their areas the provision of adequate facilities for further education. But in this undertaking they are required to consult with the university extra-mural departments and with the voluntary bodies, such as the Workers' Educational Association, which have built up traditions and developed practice in this field over very many years. The cost of lecture courses provided by these bodies is met in part by direct grants from the Ministry of Education amounting to not less than three-quarters of the lecturers' fees, subject to the classes conforming to regulations determined by the Minister. For the year 1944–45 approximately £105,000 was thus disbursed by the Ministry. Tuition is given in courses which vary in duration and in the level of instruction. Terminal and university extension courses usually extend to twelve lectures, while sessional classes normally include twenty-four lectures. Tutorial classes extend over three successive winter sessions, each session comprising twenty-four weekly meetings. In this provision for further education the representation of scientific subjects has been, and still is, very slight. During 1944–45 natural science courses in England, Wales and Scotland arranged by the Workers' Educational Association, either on its own or in co-operation with universities, amounted to not more than 4·5 per cent of the total number of courses in all subjects. This figure excludes courses in psychology (6·9 per cent of total) and in anthropology (0·2 per cent). These are customarily classed with the social sciences. In a large number of cases the approach to psychology is philosophical rather than experimental. The accompanying table records the provision of science courses during the last four sessions by the Board of Extra-Mural Studies of the University of Cambridge, having regard to the two sides of its work. Extension lectures are provided through local centres committees: tutorial and sessional classes are normally provided by joint action with the Workers' Educational Association.

Board of Extra-Mural Studies, University of Cambridge. Frequency of courses in natural sciences, 1942–46

Session	University extension courses			Tutorial and sessional classes		
	Total courses in all subjects	Courses in science*		Total courses in all subjects	Courses in science*	
		Number	Per cent of total		Number	Per cent of total
1942–43	74	1	1·4	28	3	10·7
1943–44	81	2	2·5	30	1	3·3
1944–45	93	1	1·1	63	5	7·9
1945–46	69	1	1·5	73	12	16·4

* Chiefly biology or the social relations of science.

In the latter connexion it will be observed that there has, during the last four years, been a marked expansion in the number, and, to a less extent, in the proportion, of courses in science. This growth can in part be correlated with the availability of certain tutors, chiefly biologists, and with a planned endeavour to discover reasons for the apparent lack of interest in science among adult students, an occurrence which did not correspond well with the known demand for popular books on scientific subjects. Certain aspects of that problem are discussed below.

To some extent, unfamiliarity with science on the part of organisers and administrators in adult education has put science courses at a disadvantage when, in company with more familiar alternatives such as literature, history and social studies, they have been set before potential student groups for choice to be made of a subject of study for the ensuing year. Secondly, there has been an insufficiency of scientific workers offering themselves as tutors, partly on account of indifference to the claims of such work, but also on account of an unawareness of its existence or an insufficiency of time to devote to its furtherance. Lastly, it would appear that not enough attention has always been given to the special needs, and the special limitations, of adult students by those who have been concerned with the teaching of science in extra-mural classes.

To-day it is likely that these last two groups of factors—namely, lack of scientific workers willing to teach in adult education, and lack of attention to the problems of teaching science in adult education—are the most important ones hindering the desired convergence of men of science and laymen in an educational partnership. Students and administrators alike, are coming more and more to recognize the desirability of such a development, but great difficulty is being found in the provision of suitable tutors. At the present time the teaching of science within the area served by the Cambridge Board of Extra-Mural Studies could be at once expanded if more tutors were available, science courses having had to be refused on account of the scarcity of tutors. Men of science who are anxious that their work should not become divorced from the interest and understanding of the ordinary citizen have a responsibility to give this matter their urgent consideration. For the man or woman who has the necessary abilities this work, while often arduous, is most rewarding, not least on account of the extent to which tutors can learn from their students, both in matters of fact and in matters of outlook. Tutors' expenses are found and a fee is paid according to the type of class and the degree of experience of the tutor. Work is normally on a part-time basis, and no more than one class per week need be undertaken. Thus despite the pressure of professional work it should be possible for many more scientific workers to participate in this work than are doing so at present. Persons qualified in some branch of science who would wish to share in the task of bringing the scientific point of view to their fellow citizens should get into touch either with the extra-mural department of the nearest university, or with the central office of the Workers' Educational Association, 38*a* St. George's Drive, London, S.W.1.

The writer of this article has recently published (*Discovery*, Sept.–Oct., 1946) a fuller account of techniques found useful in the teaching of science to adults, a review of the problem which it is hoped will

be of assistance to persons about to undertake work of this kind. Further, there is now an increasing tendency for extra-mural departments of universities to offer some opportunity of training to potential tutors in adult education. For example, in 1947 the Cambridge Board of Extra-Mural Studies will arrange, for the second year in succession, a fortnight's course for this purpose. It will be intended for persons with suitable academic qualifications who need advice about conducting adult classes and teaching their subjects therein. Advice about teaching methods will be given by experienced tutors, and there will be opportunities for meeting and giving practice talks to adult students. Background information concerning adult education and its development will also be given. Such courses do not claim to offer anything in the nature of a complete training, but they provide a valuable opportunity for would-be tutors to acquire some knowledge and personal experience preparatory to embarking upon an adult class.

In a short article it is only possible to consider very generally the part that science has to play in the education of adults, and the form in which it may most readily gain their attention. This is dealt with at greater length in *Adult Education*.

Experience in the area of the Cambridge Board of Extra-Mural Studies has clearly shown that, at the present time, for the majority of adults interested in adult education it is the approach by way of the social significance of science that is most successful in arousing interest, and in evoking the effort necessary for regular and effective attendance during a course of twelve or more lectures. While the social approach to science is far from being the only important one for the ordinary citizen, it is manifestly the approach of the moment. Scientific workers are accustomed to being opportunists in their own fields, doing what they can, when they can, and how they can. They would do well to employ similar tactics in bringing their subject to the notice of others.

In the hands of a skilful tutor the exposition of science in its social setting can lead to a more informed appreciation of the problems of citizenship, and to a more widespread understanding of the scientific method. Recognition of the fact that science is an activity distinguishable by its methods, rather than the simple pursuit of gadgets and cures, is still very rare among laymen. This situation is largely responsible for the continuance of the belief, still held by many, that science has no place in the liberal education of adults since it has no cultural contribution to make.

The social approach to science makes especial demands upon the tutor, who will need to be widely read outside his own subject, and able to recognize frankly his own vested interest in the scientific outlook. Tendentiousness will bring discredit upon those who practise it as tutors in an educational activity where emphasis is placed upon the need for objective inquiry on the part of students who are motivated by considerations of a practical and social character. To-day the frontiers between natural science on one hand, and psychology, economics, and philosophy on the other, are often vague and difficult of definition. This makes still greater the necessity for objectivity on the part of the tutor. Some men of science will consider it inappropriate to discuss these disputed fields in advance of a more complete study of them by the methods of science. But students will persist in bringing forward wide-ranging issues in which science is involved, such as, for example, the place of scientific method in the investigation of public opinion; the part to be played by science in the formation of opinion, both in propaganda and in education; the attitude of scientific workers to the concepts of creation, free will, democracy, and to the question of the mind–body relationship. Therefore, it would seem advisable that the tutor should be able to deal with such topics in the light of previous contemplation rather than impromptu. Scientific speculation, when self-confessed, can play an important part both in the establishment of new branches of science and in the general advancement of social awareness. It is a characteristic of adult education to be rich in demands for the study of subjects which, at present, do not fall conveniently into the conventional divisions of knowledge made by the universities for their own purposes. This is a fact the implications of which have not yet been very much explored by educationists.

Hitherto the demand for science courses of a more academic character has arisen only from a minority of adults. It is hoped that this demand will develop, both as a result of direct encouragement, and as a result of the more widespread introduction of students to science by way of the social approach. It must, however, be remembered that the intention of adult education is not to produce professional research workers; though there are a few scholarships enabling exceptionally qualified students to proceed from adult classes to full-time university courses. The hope is, rather, to increase understanding and to widen outlook. Consequently, the teaching methods employed will not necessarily coincide with those suitable for the vocational training of scientific workers. Experience suggests that it is usually better to build up the more academic type of treatment in relation to topics in which there is already some considerable amount of amateur activity. These may be matters of local interest, including natural history; or subjects with vocational aspects, such as gardening, home nursing, motor-car maintenance, or radio. Courses in biology have been very successful when based upon the interests of local field clubs. It is recognized that courses of this type must be as fully experimental as possible—a provision which in adult education still presents many difficulties from the point of view of organisation.

With respect to both of the routes by which science may be approached, whether social or academic, it is biologists who have made the greatest progress in the business of relating their material to the needs of the ordinary man. It has been said that this has largely resulted from the advantages which biology enjoys with respect to its subject-matter and its methods. With respect to methods, genetics is a department of biology that is to a great extent dependent upon mathematical techniques, and which, like physics and chemistry, is advanced by the use of symbols. Nevertheless, the popularizers of biology have to a considerable extent found it possible to include the subject-matter of genetics within their purview. So far as interest value is concerned, physicists and chemists have acquired a powerful pull on the public mind with the opening of the age of atomic energy. The success of certain carefully designed books expounding the physical sciences for the ordinary man leaves one with the impression that in lecture courses much could be done with similar subject-matter. Indeed, the experience, not only of

an earlier generation but also of more recent years, is that public interest is keen if lecture courses on such topics are given by lecturers who have the necessary gift of lucid exposition and an ability to relate their subject-matter to the familiar experiences of everyday life. If more physical scientific workers of the present generation would devote time to discovering, by trial and error, techniques suited to the popular exposition of their subjects through the spoken word, these sciences might within a few years come to be as much in demand as the biological sciences.

But experience in adult education suggests that it is not necessary, nor even desirable, for lecturers in science to confine themselves too narrowly within their own research subjects, any more than occurs with school teachers or schools' examiners. Scientific workers when participating in adult education are not authorities addressing their professional equals, but expositors serving the needs of laymen. Their position closely resembles that of the political commentator attempting to assist public understanding of current affairs. Indeed, they may even prove to be more effective as tutors if they can share some of the difficulties experienced by their students when surveying the territory of science. To-day, scientific workers are presented with great opportunities in the field of adult education. Are they willing and ready to take advantage of them ?

THE INTERNATIONAL UNION OF PHYSICS

ACTIVITIES OF THE UNION, 1923–39

AT the close of the First World War, the main pre-war international scientific organisations, some of which had been dominated by Germany, had collapsed. It was therefore decided to create a series of scientific unions to promote international co-operation. The Union of Pure and Applied Physics was formed at the end of 1923. In 1934 the Union held its most important assembly of the inter-war period. At this assembly, which was held in London, it received a report from the Commission on Standards, Units and Nomenclature which it had previously established. It approved recommendations concerning (*a*) thermal units, (*b*) units and nomenclature of electromagnetism (including the adoption of the 'oersted'), and (*c*) the nomenclature of thermodynamics. It decided that the Commission should continue its work, and should (i) co-operate with other international bodies in relation to definitions of terms, (ii) prepare lists and definitions of terms occurring in two or more branches of physics, and (iii) assist those who, in any country, are preparing such lists. The Commission was not intended to conduct technical investigations, such as those guided by the International Commission on Illumination. It was to receive and to review data prepared by technical commissions and to decide whether to recommend their general adoption by physicists. Associated with the 1934 Assembly was a public conference, including sections on (*a*) nuclear physics, and (*b*) the solid state. This very successful conference was held jointly with the Physical Society of London, which was mainly responsible for the organisation.

The work of the International Union of Physics may fairly be compared with that of some of the other unions which are also members of the International Council of Scientific Unions. The International Astronomical Union united thirty-four standing committees and organised many important research projects. The Union of Geodesy and Geophysics was also very active. On the other hand, the projected Union of Biological Sciences never achieved biological existence ! The International Union of Pure and Applied Physics was useful—but in a limited way. One reason for its rather slight activity was that its constituent members, the national committees, were not very active in any country, and were non-existent in many.

The Assembly in Paris, January 1947

Against this background we may now consider the recent assembly held at the Sorbonne with Prof. M. Siegbahn (Sweden) as president. The secretary was Prof. P. P. Ewald (Belfast). He had undertaken the office, at the request of the president, after the death of Prof. Abraham, who had been secretary since 1923. The local arrangements were made by Prof. Fleury (director of the Institut d'Optique). The conference recognized that it owed more than a formal vote of thanks to Prof. Ewald and Prof. Fleury, whose hard work in very difficult circumstances enabled it to function smoothly. The following countries were represented : Australia, Belgium, China, Czechoslovakia, Denmark, France, Finland, Great Britain, Italy, Netherlands, Norway, Poland, Spain, Sweden, Switzerland.

From this list it may be seen that Western Europe is well represented, and there were also some scientific workers from Eastern Europe, although the U.S.S.R. did not accept the invitation to attend. It is hoped that the causes which prevented the representation of the United States, Canada and India are purely temporary, and that they will send delegates to the next assembly. It was suggested that ex-enemy States may also be invited as soon as peace treaties have been signed.

Apart from the necessary business of electing new officers, etc., which will be dealt with later, the chief discussion centred on the future policy of the Union. There were two chief schools of thought. The first view (sponsored by the Dutch delegation) was that the assembly should give a strong lead by appointing a large number of commissions to organise international co-operation in various branches of physics. It was urged that if this were not done, various organisations independent of the International Union of Physics would come into existence. Already a Union of Applied Mechanics and a Union of Crystallography have been formed. The Réunion des Opticiens held in Paris in October appointed a continuation committee to organise international co-operation in optics. This committee is at present willing to work as part of the International Union of Physics if possible. The Dutch delegates urged the formation of Commissions for Optics, Nuclear Physics, Low Temperatures, Magnetism, Metals, Spectrum Analysis, Cosmic Rays, Crystallography and Mechanics. On the other hand, some delegates felt that an attempt to 'organise physics from above' would certainly fail. Co-operation must be a matter of organic growth. It was believed that all the International Union can do is to recognize an urge for co-operation among a group of workers when it occurs spontaneously (as had happened with optics) and give the support of the Union.

Clearly, either of these arguments pushed to extremes must lead to absurdity. Too ambitious a programme at present would lead to a cumbersome international 'organisation' with nothing to organise. On the other hand, if the Union always waited for sections to make their plans complete, those in favour of co-operation would form separate unions, and the Union of Physics would lose its *raison d'être*. The British delegates suggested that physical sciences can, for purposes of international co-operation, be divided into two groups. The first group includes subjects such as cosmic rays and physics of the atmosphere, in which observations made at different parts of the earth's surface are complementary. An international organisation of those branches of physics may expect to undertake important projects of research which no one country could organise. The second group includes subjects such as optics and acoustics, which are concerned with the measurement of quantities which do not vary with latitude and longitude. International projects of research are likely to be less important in these subjects—though they are not impossible. Both groups of sciences may expect to benefit from international discussion of units and nomenclature and from personal contacts. On this view the International Union should establish commissions where important research projects are possible, and also where there is evidence that workers in a certain branch of physics would welcome the formation of a commission. It was decided to establish the following commissions:

(1) *Cosmic Rays:* to study the possibility of international co-operation in observations. *Chairman:* J. Clay; *Secretary:* P. Auger; *Members:* P. M. S. Blackett, W. Heitler, B. Gross, B. Rossi.

(2) *Units of Radioactivity:* to consider the proposals of Condon and Curtiss (see *Rev. Sci. Instr.*, June 1946). *Chairman:* E. U. Condon; *Members:* L. F. Curtiss, Sir Charles Darwin, E. Evans, J. C. Jacobsen, Mme. Joliot, M. Siegbahn, C. G. J. Sizoo.

(3) *Symbols, Units and Nomenclature:* to continue the work of the former commission. *Members:* P. Fleury, Ezer Griffiths, A. Pérard, Van Dijk.

(4) *Thermodynamics:* to study the definitions and nomenclature of thermodynamics and thermochemistry and to co-operate with the Commission on Standards, Units and Nomenclature, and with the International Union of Chemistry. *Members:* E. Bauer, De Boer and E. A. Guggenheim.

(5) *Optics:* to form a preparatory commission to consult the Optical Groups of various countries on the best way to bring the organisation proposed at the Réunion des Opticiens (held in October) within the framework of the International Union of Physics. The members of the preparatory commission are to co-opt persons chosen by the Optical Groups in each country so as to form a fully representative commission, the full commission to meet at an early date (probably in June at Prague). *Secretary:* P. Fleury; *Members:* R. W. Ditchburn, J. Hrdlička, E. Perucca and A. C. S. Van Heel.

The conference also appointed representatives on joint commissions dealing with (*a*) physico-chemical data, (*b*) viscosity, (*c*) the ionosphere, (*d*) radio-meteorology.

The Assembly elected Prof. Kramers as president, Prof. Fleury as secretary and Prof. Pérard as treasurer. A number of vice-presidents, including Sir Charles Darwin, were also elected. The officers form an executive committee to act until the next assembly. The executive has power to form further commissions if there is evidence that this is desired. Any suggestion for the formation of a new commission or for any other project of international co-operation may be made to the executive through a national committee for physics.

Relations with the United Nations Educational, Scientific and Cultural Organisation

The Assembly received a report of an agreement between the United Nations Educational, Scientific and Cultural Organisation and the International Council of Scientific Unions. Under this agreement the Organisation recognizes the International Scientific Unions as "providing a natural form for the international organisation of science". It agrees to help them financially in regard to (*a*) international research projects, (*b*) travel expenditure, and (*c*) provision of office space, secretarial service in arrangement of meetings, etc., but *not* the general secretarial expenses of the Unions. It is expected that in conjunction with the Organisation the International Union of Physics may undertake the compilation of panels of experts in every branch of physics and, later, the publication of an international directory of physics. This directory is to include lists of laboratories with the names of workers and types of research. Other projects discussed include the publication of 'handbooks' of a type too expensive for one nation and the establishment of archives (that is, records, such as manuscripts, films, etc., of experiments and of persons of historical importance).

It was recognized that the details of co-operation with the United Nations Educational, Scientific and Cultural Organisation must be worked out gradually over a period of years; but it was felt that the agreement with the Organisation alters the whole outlook of the International Unions. They should now have sufficient funds for all useful work which lies within their terms of reference, and the backing of a permanent secretariat and a permanent organisation.

The Assembly decided to meet again in September 1948 in Holland. The interval is shorter than the usual interval of three years between meetings of the assembly, but a fairly early meeting is desirable to review the working of the new commissions and to make any alterations in statutes which may be needed to secure the full benefit of co-operation with the United Nations Educational, Scientific and Cultural Organisation.

Conclusion

May I conclude this article on a note of optimism —*restrained* optimism, but still optimism—concerning the future of the Union. The Paris Assembly was a friendly conference and its programme, although not excessively ambitious, is practical. Each of the commissions exists to meet a demand—and has therefore a definite and natural field of reference. It may be that more commissions ought to have been set up, but if the demand for this or any other useful action arises before 1948, the executive can act. Finally, the agreement with the United Nations Educational, Scientific and Cultural Organisation offers the prospect of achieving stable and permanent co-operation in science. The extent of this co-operation may be expected to grow. The rate of growth will depend on the support received from national and local scientific societies and from individual scientific workers.

R. W. Ditchburn

OBITUARIES

Dr. Alexander Scott, F.R.S.

At the great age of ninety-three, Dr. Alexander Scott died at Ringwood, Hampshire, on March 10. He was educated at Selkirk Grammar School, of which his father was rector, and at the University of Edinburgh, where he took first place in chemistry. In 1875 he became assistant to the Jacksonian professor at Cambridge, and having been awarded a Clothworkers' Exhibition in 1876 and a foundation scholarship of Trinity College in 1878, he gained a first class in the Natural Sciences Tripos in 1879.

From 1884 Scott spent seven years organising the teaching of science in Durham School and Middlesbrough High School. It was while here that Scott found the teaching of science in poor case, being handicapped by science masters either ill-trained or having to subordinate their efforts to preparing their pupils for answering the highly specialized questions of scholarship examinations. In his presidential address to the Chemical Society in 1916, the opportunity for successful careers for science students is compared with the rewards open to classical or mathematical students, and an appeal is made for a change in outlook. Whatever our views may be as to the early concentration on purely scientific subjects, it must be allowed that some progress has now been made in the betterment of the position of the scientific man.

Returning to Cambridge in 1891, Scott resumed work under Dewar, the Jacksonian professor, but five years later removed to London, where he became superintendent of the Davy Faraday Research Laboratory of the Royal Institution (1896–1911), Dewar being director. This Laboratory had been provided by Dr. Ludwig Mond in 1896 to afford opportunities for skilled men with the wish and time to devote to the solution of important problems.

Here Scott for fifteen years devoted himself to chemical work, which he pushed to the highest degree of accuracy, in his determination of atomic weights and of fundamental ratios such as that between hydrogen and oxygen.

Impressed by the accuracy of the work of Stas and by the view of that chemist of the illusory character of Prout's hypothesis—that the atomic weights of the elements are multiples of that of hydrogen—he remarks in his second presidential address to the Chemical Society that under its spell everyone falls who engages in work on atomic weights. This spell had certainly its influence on Scott, who by his skill and critical faculty clearly showed that Prout's hypothesis, in its original acceptation, could not be maintained; but he held that no work undertaken to determine the atomic weight of any element has led directly or indirectly to such an "increase in natural knowledge" as that centring around nitrogen, on which he did much careful work. Before the subject was cleared up by the discovery of isotopes, Scott in 1917 looked forward "to future investigation to focus out what is the true expression underlying Prout's principle", so that it would "lose its character as a will-of-the-wisp which it had borne in the eyes of so many distinguished men for a hundred years".

In his position as superintendent of the Davy Faraday Research Laboratory, Scott's relations with the workers there were amicable and helpful; many of them are now well known for the researches which they completed during their stay or as a result of further labours after leaving. Among them were Horace T. Brown, H. Debus, A. Liversidge, A. Mallock, Hugo Müller, Joseph Petavel, Charles E. S. Phillips, P. C. Ray, W. J. Russell, G. Senter and H. T. Tizard. Intolerant of slipshod work, Scott held the respect of his staff and showed a kindly friendliness to the sincere worker, a phrase used recently by one of the workers of that time now with us.

Scott was secretary to the Chemical Society (1899–1904) and treasurer (1904–15), much to the benefit of that Society; during 1915–17 he was its president. He was elected into the Royal Society in 1898, and elected a member of the Athenæum under Rule II in 1923. In 1906 he married Agnes Mary, daughter of Dr. W. J. Russell, F.R.S., and leaves no family.

Robert Robertson

I first met Dr. Scott when he was seventy-one years of age: erect, with an imposing presence and an immense fund of scientific knowledge; critical, but, as I was to discover, with a capacity for kindness and friendship which can seldom have been surpassed. In 1919 he was invited by the Department of Scientific and Industrial Research at the instance of the Trustees of the British Museum to prepare a report on the condition of museum objects subsequent to their storage in a war-time repository. In accordance with his recommendation, a research laboratory was established at the British Museum, and he was director there until his retirement in 1931. I had the honour to be his assistant. During this period he made various important contributions to restoration work in the fields of archæology and painting, and such studies were his absorbing interest until the last.

Scott was particularly fitted to make these investigations. His career of service to chemistry had by no means precluded ancillary studies: he was a keen botanist and was prepared to tackle almost any inquiry in his private laboratory at home, from the most exacting work on atomic weights to the microscopical identification of plant structures. He was interested in solving problems for their own sake and could not resist the urge to experimentation. Thus it was that his advice was sought by all and sundry, and it was given generously and gratuitously.

He visited Luxor in 1923 and co-operated with Dr. Howard Carter and his chemical advisor, Alfred Lucas, in the prodigious task of organising the preservation of the objects from the tomb of Tutankh-Amun discovered the previous year—a task which was, as all the world knows, accomplished in the most trying circumstances with outstanding success.

It can have fallen to few to live the full life of service to science described above by Sir Robert Robertson, and to go beyond this and find time and energy in his latter years to become an authority of international repute in an entirely new field. If for nothing else, the name of Alexander Scott will be remembered for his pioneer work in inculcating the laboratory idea in museums: the recent development of this section of museology both in Great Britain and abroad bears testimony to his vision and judgment.

In the quality of his accomplishments Scott was a great man. He was, in addition, a notable benefactor to scientific research and, in my own knowledge, he helped many to a settled and happy life. He lived for science and truth, and found in this creed the formula of happiness.

H. J. Plenderleith

Sir Joseph Barcroft, C.B.E., F.R.S.

On March 21 Sir Joseph Barcroft died suddenly at Cambridge from a heart attack. He had been hurrying to catch the bus which took him home from the Physiological Laboratory; he was seventy-four, and arthritis had begun to make cycling difficult, but this was the only sign that he was no longer as vigorous as ever. His occasional lectures were no less stimulating, he was an inspiring chairman of the newly formed Nutrition Society, an active member of countless committees, and after fifty years of research he could still open up unexplored fields and arouse the enthusiasm of the students who crowded his laboratory. He had just finished his yearly researches on the embryo sheep and had seen the publication of his new volume on fœtal physiology, "Researches on Pre-Natal Life" (see review by Dr. F. H. A. Marshall in *Nature* of March 22). He would have faced retirement philosophically; but his friends may be glad that he had no need to become inactive.

Barcroft was born on July 26, 1872, son of the late Henry Barcroft, of Newry, Co. Down. His family were Quakers, settled in Ireland since the seventeenth century, and their way of life must have been partly responsible for his calm but unrelenting pursuit of knowledge. He went to Bootham School, York, and then to the Leys School, Cambridge, entering King's College, Cambridge, in 1894. After a first class in both parts of the Natural Sciences Tripos he became demonstrator in physiology to Prof. Langley. In 1915 and again in 1939 he left academic physiology to work on the problems of gas warfare, but the rest of his life was spent in Cambridge, as professor of physiology from 1925 until 1937, and as director of the Agricultural Research Council Research Unit in Animal Physiology from 1941 onwards.

His work in physiology was always that of a pioneer; he had a genius for finding uncharted territory even in the most familiar regions, and for solving well-worn problems by an approach at a new angle. There are three major fields in which his work is classical: the physical chemistry of oxyhæmoglobin, the distribution of the blood between the storage depots and the circulation, and the physiology of fœtal life. In all three he set the fashion in current physiological research, but though many workers came to him for inspiration at each stage in his scientific career, he refused to become the specialist, and moved on as soon as he was satisfied that the main outlines were settled. He settled them by simple methods and simple ideas, leaving the complexities to be cleared up by those who understood them, but very rarely misjudging the main issues. He had, in fact, a wide range of scientific knowledge at his disposal and was at home with physical and chemical as well as biological ideas; but he knew the plain speech of the Quakers and wrote and spoke as a plain man with no claim to superior learning. He used to quote with delight the tribute of a foreign physiologist who said: "I like your book, Barcroft. It is so clearly wrotten!"

Besides their clarity, Barcroft's books are written with an engaging friendliness. They speak of yachting, travel and companions as accessories to physiological research, and no one who reads them will wonder at the constant stream of young men who came to him for training and encouragement. He was never at a loss for problems suited to the beginner or to the senior colleague; he knew where to go for help when some new technique was needed, whether its home was in Cambridge or abroad, and he could always attract a small army of collaborators when one of his major investigations was afoot.

Many honours came to Barcroft, including the Copley Medal of the Royal Society. Though he worked very hard, he was never too busy to help those who came to him for advice, and many did so. He could be relied on to introduce a speaker or propose a toast with a charming blend of humour and good sense, and in a private gathering he was the best of company. His sturdy figure will be greatly missed at the forthcoming International Congress of Physiology, for he had become one of the elder statesmen of the science, although he was never out of touch with the rank and file. There must be laboratories in all parts of the world where Barcroft will be remembered with esteem and affection for his personal qualities even more than for his great achievement as a physiologist. E. D. Adrian

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We regret to announce the following deaths:

Mr. W. J. Bean, C.V.O., formerly curator of the Royal Botanic Gardens, Kew, on April 19, aged eighty-three.

Dr. J. D. Falconer, formerly director of the Geological Survey of Nigeria, on April 16, aged seventy.

NEWS and VIEWS

Reports on Penicillin

The Medical Research Council, acting on the advice of its Committee for Penicillin Synthesis, is making available for consultation by interested persons a number of reports on penicillin. In October 1943, when many of the structural features of the penicillin molecule were becoming clear through the work carried out in Great Britain, the problem of the synthesis became a pressing one, and to handle this aspect, the Medical Research Council set up a Committee for Penicillin Synthesis "to initiate, co-ordinate and make investigations on the synthesis of penicillin and analogues". At the same time the Committee for Medical Research of the Office of Scientific Research and Development in Washington, which had already undertaken the co-ordination of chemical work on penicillin in the United States, came to an agreement with the Medical Research Council for an exchange of information on anything which had a bearing on the problem of the synthesis of penicillin. The confidential reports which were issued and exchanged are known in Great Britain as the C.P.S. reports. A number of reports known as the Pen. reports and sponsored by the Therapeutic Research Corporation of Great Britain contain much information of historical value on the earlier work carried out on the structure of penicillin.

All these reports, together with others sponsored by Imperial Chemical (Pharmaceuticals) Ltd., Merck and Co. Inc., and the Squibb Institute for Medical Research, are now available for consultation in certain libraries in Great Britain. In the London

area the reports may be consulted in the libraries of the Royal Society; National Institute for Medical Research; British Drug Houses, Ltd.; Glaxo Laboratories, Ltd.; Wellcome Chemical Research Laboratories, Beckenham; May and Baker, Ltd., Dagenham; and in the provinces in the libraries of the Universities of Birmingham, Bristol, Cambridge, Glasgow, Manchester and Oxford. In the Nottingham area the reports may be consulted in the library of Boots Pure Drug Co., Ltd. The information contained in these reports cannot be made the subject of any publication before the Penicillin Monograph appears later in the year.

Biochemistry at Guy's Hospital Medical School: Prof. R. H. S. Thompson

THE appointment of Dr. R. H. S. Thompson to the new University chair of chemical pathology at Guy's Hospital Medical School, London, is no surprise to those acquainted with his work. During the course of a distinguished career, he has been concerned in some twenty-nine publications covering several aspects of biochemistry. As a Millard scholar of Trinity College, Oxford, he early showed promise and became senior demy of Magdalen College in 1933. At this time he worked with Prof. R. A. Peters upon the role of vitamin B_1 in the metabolism of pyruvic acid in brain; extending the work (with R. E. Johnson) to the important observation, now applied clinically, of increased pyruvic acid in blood in the terminal conditions of this deficiency. Following this, as a scholar at Guy's Hospital, he was awarded the Laidlaw Prize in 1937 and published research with Prof. G. Payling Wright on the chemistry of Gaucher's disease. As the Adrian Stokes travelling fellow, working with Dr. Dubos at the Rockefeller Institute in New York (1937–38), he published work upon the important enzyme ribonuclease, and upon the production of experimental osteomyelitis. Upon his return to Oxford in 1938, he became University demonstrator in biochemistry and fellow and tutor of University College. Since 1946, he has acted as dean of the Medical School. At the outbreak of the War he joined the team working upon antidotes to the war gases under the direction of Prof. Peters and took a prominent part with Dr. L. A. Stocken in the discovery and development of British anti-lewisite (2-3 dimercaptopropenol). He has also been much concerned with the clinical developments of this substance and is now acting as secretary of the Medical Research Council Conference on *B.A.L.* During the War he also co-operated with Netley Hospital in the nutritional treatment of post-arsphenamine jaundice, and in 1944–46 was attached to the Australian Army as Major, R.A.M.C. He was awarded in 1943 the Radcliffe Prize for medical research, Oxford.

University College, Nottingham: School of Agriculture

THE Midland Agricultural College at Sutton Bonington has become the University College of Nottingham School of Agriculture. The Midland Agricultural College has had a long and distinguished association with agricultural and dairying education. The agricultural section started as the agricultural department of University College, Nottingham, in 1892. In 1895 the Midland Dairy Institute was established at Kingston-on-Soar, and in 1900 the agricultural department was moved out into the country to link up with the dairy side. The subsequent development of the Midland Agricultural College was due very largely to the four local county councils of Derbyshire, Leicestershire, Lindsey and Nottinghamshire. In 1942 the governing body made recommendations to the associated county councils that the immediate needs of agricultural education could be served by the development of farm institutes in the counties and that the College should be reserved for higher agricultural education and research; in 1943 the University College of Nottingham instituted a Faculty of Agriculture and Horticulture, and the principal of the Midland Agricultural College was appointed to the staff of the University College as the professor of agriculture. University College, Nottingham, has bought out the county council interests in the Midland College, and the money will be used by the councils in the development of county farm institutes.

The entire staff of the Midland Agricultural College is being transferred to the staff of the University College of Nottingham. Prof. H. G. Robinson, who has been at Sutton Bonington for twenty-two years and for the last twelve years as principal, becomes the first director of the new School of Agriculture. The present student population in the Faculty of Agriculture and Horticulture numbers 240. Developments envisaged at Sutton Bonington in the near future provide for a considerable extension of the facilities in the Horticultural Department. A scheme costing £15,000 has been approved in this connexion and is being assisted by the Ministry of Agriculture. As a result of this development, Nottingham will have a centre of higher agricultural education that will fit into the general scheme of agricultural education that is now being planned for the country as a whole. So far as horticulture is concerned, Nottingham will have to cater for the educational needs of the northern half of England.

Birds of Heligoland

MINOR discharges were used to arouse the sea-birds of Heligoland so as to avoid their destruction in the greater explosions which marked the destruction of the fortifications of the island. The island is to revert to its pre-war use as an ornithological centre for migration studies. The nesting birds of Heligoland are comparatively few: its importance in the North Sea off the Elbe estuary lies in the facilities it has offered for the study of bird migration during spring and autumn. The Heligoland design of bird recovery trap, originally adapted for bird-ringing pursuits off South Wales, is being utilized in the formation of a chain of independent bird-study stations around the British Isles at Fair Island, the Spurn, Lundy Island, Milford Haven and elsewhere. As many as 9,000 starlings were caught, marked and released on Heligoland during one pre-war migration in the studies organised by the German State Biological Bureau under the direction of Dr. Rudolf Drost and Dr. Shildmacher. In nine days on one occasion 1,130 birds were ringed: these included 271 blackbirds, 220 song thrushes, 105 redbreasts and 144 skylarks. The German Ministry of Agriculture helped to finance these studies.

German Scientific and other Periodicals

THE Association of Special Libraries and Information Bureaux has prepared a classified list of German periodicals, excluding newspapers, official gazettes, local organs of political parties, trade unions and churches, devotional literature and popular periodicals

(from the Association, 52 Bloomsbury Street, London, W.C.1. 1s.). The list is largely based on two published bibliographies, "Die deutsche Presse, 1946" and "A Check-list of Current Serials in the United States Zone of Germany". Orders for such periodicals for not less than six months subscription will be accepted on behalf of H.M. Stationery Office by the Secretary, Enemy War-time Publications Requirements Committee, Control Commission for Germany and Austria, Norfolk House, St. James's Square, London, S.W.1 (see also *Nature*, March 15, p. 366).

Spectrographic Terminology

THE Spectrographic Discussion Group at Glasgow has produced a pamphlet (University Press, Aberdeen, 1946) entitled "Suggested Definitions of Terms used in Spectrographic Analysis". This recommends a set of symbols for various spectrographic constants and suggests definitions of a large number of terms used in this type of work. The chairman of the group, Mr. S. D. Steele (c/o Messrs. Babcock and Wilcox, Renfrew, Scotland), offers to send a free copy of the pamphlet to interested persons and will welcome criticism and suggestions. The proposed symbols do not, in general, appear to conform to the principles laid down by the Joint Report of the Chemical, Faraday and Physical Societies (1937).

Fourth International Congress for Microbiology

THE International Association of Microbiologists is organising the Fourth International Congress for Microbiology, to be held at Copenhagen during July 20–26, 1947. General meetings will be addressed by Dr. F. C. Bawden (Rothamsted Experimental Station) on viruses, Prof. S. A. Waksman (New Jersey State Agricultural Experiment Station) on antibiotics and life, Prof. C. H. Werkman (Iowa State College) on the assimilation of carbon dioxide, and Prof. Ø. Winge (University of Copenhagen) on yeast in modern genetics. The nine sections of the Congress will be devoted respectively to general microbiology, medical and veterinary bacteriology, viruses and virus diseases, serology and immunology, variation and mutation in micro-organisms, plant pathology and mycology, soil and water microbiology, dairy and food microbiology, and industrial microbiology. The president of the Congress is Dr. Th. Madsen; and the honorary general secretary is Dr. M. Bjørneboe, Kommunehospitalet, Copenhagen. Those wishing to take advantage of official arrangements for hotel accommodation should communicate with the honorary general secretary not later than May 15.

Institute of Industrial Administration Summer School

THE Institute of Industrial Administration has arranged a summer school for 'management teachers', to be held at Oriel College, Oxford, during July 26–August 2. The purpose of the School is to give selected persons, responsible for the teaching of management subjects (full- and part-time), an opportunity to explore the syllabuses proposed by the Ministry of Education Committee on Education for Management and to discuss the practical teaching problems arising from it. The School will be residential and will be conducted in lecture and tutorial sessions. The chairman of the School is Major L. Urwick, chairman, Ministry of Education Committee on Education for Management. Guests will include delegates from the United States to the Eighth International Congress for Scientific Management, Stockholm, in July. The Ministry of Education will be represented, and the 'Assembly' address will be delivered by Sir David Ross, provost of Oriel College. Application for forms and programmes should be made to: Assistant Secretary (Education), Institute of Industrial Administration, Artillery House, Artillery Row, London, S.W.1.

Summer School in Relaxation Methods

A SUMMER school in 'Relaxation Methods' will be held at the Imperial College of Science and Technology, London, during the four weeks July 8–August 1. It would seem that there is no great difficulty in acquiring such knowledge of the relaxational technique as is required to solve ordinary engineering problems (frameworks, electrical networks, etc.), so it is proposed this year to concentrate on problems involving partial differential equations in two independent variables. The course will consist of more or less formal lectures, with numerous examples to be solved under supervision; lectures will be given on Tuesdays–Fridays only, but facilities for practical work will be also provided on Mondays and (if requested) on Saturday mornings. Further particulars can be obtained from Mr. D. N. de G. Allen, Imperial College, London, S.W.7.

School of Cosmic Physics, Dublin

THE inaugural meeting of the School of Cosmic Physics in the Dublin Institute for Advanced Studies was held on March 27. The following have been appointed by the President, on the advice of the Government of Eire, to be senior professors of the School: Dr. L. W. Pollak, senior meteorological officer, Department of Industry and Commerce, Eire (from April 1); Dr. L. Jánossy, I.C.I. fellow at the University of Manchester (from July 1, 1947); and Dr. H. A. Brück, assistant director, Cambridge Observatory (from October 1, 1947).

University of London: Appointments

THE following appointments in the University of London have been announced: Prof. S. W. Wooldridge, professor of geography at Birkbeck College, to the University chair of geography tenable at King's College, as from October 1; Dr. P. R. Crowe, senior lecturer in geography in the University of Glasgow, to the University readership in geography tenable at Queen Mary College, as from October 1; Dr. Alfred Schweitzer, lecturer in physiology in the University of Leeds, to the University readership in experimental physiology tenable at University College, as from October 1; Mr. A. W. Skempton, senior lecturer in civil engineering at the Imperial College of Science and Technology, to the University readership in soil mechanics tenable at the College, as from October 1, 1946; Mr. J. R. Gilmour, to the University readership in morbid anatomy tenable at London Hospital Medical College, as from October 1. The title of professor of mathematics in the University has been conferred on Dr. W. G. Bickley, in respect of the post held by him at the Imperial College of Science and Technology.

Colonial Service Appointments

THE following appointments have been made in the Colonial Service: Capt. C. N. Coombes, agricultural economist, Gold Coast; W. B. Tevendale, geologist, Gold Coast; Flight-Lieut. K. V. W. Nicholls, meteorological officer, Malaya; Flight-Lieut. R. C.

Bannister, professional assistant, Royal Observatory, Hong Kong; G. J. Lockley, fishery officer, Tanganyika; H. E. C. Lushington, senior assistant conservator of forests, Ceylon, to be conservator of forests, Ceylon; E. W. March, assistant conservator of forests, Ceylon, to be conservator of forests, Jamaica; L. G. T. Wigg, assistant conservator of forests, Tanganyika, to be senior assistant conservator of forests, Tanganyika.

Recent Comets

Comet Rondanina–Bester (1947*b*) was discovered by Rondanina and independently by Bester at Bloemfontein on March 24. Its magnitude at the time of discovery was 11, and its daily motion was rather rapid, suggesting that it was fairly close to the earth. Dr. L. E. Cunningham computed an orbit and a short ephemeris which has been continued by Dr. G. Merton; these are given below.

T 1947, May 20·913 U.T.
ϖ 303° 41′
Ω 353 13 } 1947·0
i 39 22
q 0·5599

Ephemeris

1947	0h R.A.	Dec.	r	ρ	Mag.
May 3	2h 21·1m	−27° 22′	0·643	0·728	9·5
7	18·9	22 02			
11	17·7	16 55	0·576	0·861	9·4
15	17·7	12 00			
19	19·1	7 00	0·562	1·001	9·6
23	21·9	2 28			
27	26·0	+ 2 05	0·605	1·137	10·2
31	31·4	6 26			

Comet Bečvář (1947*c*) was discovered on March 27 by Dr. Bečvář, Observatory Skalnaté Pleso. He described it as diffuse, without central condensation or nucleus, and its magnitude was 9. Dr. Cunningham has computed an orbit and ephemeris for this comet also, the ephemeris having been extended by Dr. Merton.

T 1947, May 3·971 U.T.
ϖ 182° 25′
Ω 322 35 } 1947·0
i 128 58
q 0·9609

Ephemeris

1947	0h R.A.	Dec.	r	ρ	Mag.
May 3	6h 0·9m	+22° 52′	0·962	1·362	10·5
7	1·6	19 40			
11	2·1	16 53	0·980	1·550	10·9
15	2·4	14 28			
19	2·6	12 18	1·017	1·719	11·3
23	2·8	+10 21			

The Night Sky in May

Full moon occurs on May 5d. 04h. 53m. U.T., and new moon on May 20d. 13h. 44m. The following conjunctions with the moon take place: May 6d. 00h., Jupiter 0·4° N.; May 18d. 09h., Mars 2° N.; May 18d. 10h., Venus 1° N.; May 24d. 23h., Saturn 4° S. In addition to these conjunctions with the moon, Venus is in conjunction with Mars on May 17d. 12h., Venus being 1·0° S. Mercury is in superior conjunction on May 15. Towards the end of the month, the planet sets 1½ hours after the sun and can be seen as an evening star. Venus rises about half an hour before the sun on May 1 and 50 min. before sunrise on May 31, and can be seen in the eastern sky, stellar magnitude −3·3. Mars can be observed as a morning star for a short period before sunrise, rising at 4h., 3h. 21m., and 2h. 41m. at the beginning, middle and end of the month respectively. Jupiter, in the constellation Libra, is visible until the early morning hours, setting after sunrise during the first half of May. Saturn, in the constellation Cancer, can be seen only during the early part of the night, setting at 1h. 36m., 0h. 43m., and 23h. 43m., at the beginning, middle and end of the month, respectively. Only one occultation of stars brighter than magnitude 6 takes place in the month, on May 23d. 22h. 10·5m., *A* Gemi. (*D*). The latitude of Greenwich is assumed, and *D* refers to disappearance. A total eclipse of the sun on May 20 is visible over portions of South America and central Africa, and preparations have been made to observe it (see *Nature*, March 1, p. 287); the British expedition has been cancelled following the deaths of two of the party in an aeroplane crash.

Announcements

The Lord President of the Council has approved the appointment of Dr. Franklin Kidd, superintendent of the Low Temperature Research Station, as director of food investigation, Department of Scientific and Industrial Research, in succession to Dr. C. S. Hanes, who has become head of a unit of biochemistry that is being set up at the University of Cambridge by the Agricultural Research Council. Dr. E. C. Bate-Smith, senior principal scientific officer at the Low Temperature Research Station, has been appointed superintendent of the Station.

Dr. Geoffrey Gee has been appointed director of research of the British Rubber Producers' Research Association in succession to Mr. J. Wilson.

Dr. H. Cullumbine has been appointed professor of physiology in the University of Ceylon, which came into existence in 1942 by the incorporation of the Ceylon University College (founded in 1921) and the Ceylon Medical College (founded in 1870). During the War, Dr. Cullumbine was engaged in research in the Physiology Department of the Chemical Defence Experimental Station, Porton, and since then he has worked in the Department of Pharmacology, University of Manchester.

The fourth Mercer Lecture of the Society of Dyers and Colourists will be delivered on May 2 at the Royal Technical College, Glasgow, by Mr. E. J. Bowen, of University College, Oxford, who will speak on "Colour and Constitution: Absorption of Light by Chemical Compounds".

The annual malaria control courses for planters, miners and others are to be resumed at the London School of Hygiene and Tropical Medicine. This year the course will be held at the School during June 23–27. The course is free. Applications to attend should be sent as early as possible to the Organising Secretary, Ross Institute of Tropical Hygiene, Keppel Street, Gower Street, London, W.C.1.

The Trustees of the Ramsay Memorial Fellowships for chemical research will consider at the end of June applications for one fellowship of value £300 per annum, tenable for two years. Particulars can be obtained from the joint honorary secretaries, Ramsay Memorial Fellowships Trust, University College, London (Gower Street), W.C.1, to whom applications must be forwarded not later than May 31.

The suggested summer school in X-ray crystallography at Manchester (see *Nature*, March 22, p. 398) will be held during September 1–12. Applications to attend must be received not later than May 12.

Erratum. In *Nature* of March 22, p. 387, review of "The Milky Way": the longest axis of the Galaxy is more than 100 thousand light-years, not 100 million light-years as printed.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Neutron Experiments of the Physical Laboratory of Groningen

In the beginning of 1940, a few months before the occupation of Holland by the Germans, we started some neutron experiments in this Laboratory (see ref. 1). To determine neutron energies the well-known boron absorption method was applied. Following Frisch's example[2], boron was used not as a compound but in the pure amorphous state. This boron arrived in March 1940 in Groningen from the British Drug Houses, Ltd. As it yielded nearly the same results as a sample of amorphous boron from Merck (Germany) which we had still in the laboratory, we had not the slightest suspicion that our results could be spoiled by too high an amount of impurities.

That this was really the case could be anticipated as soon as the new results for the resonance energies of silver and other elements, which had been found by the time of flight method, had been published[3,4,5].

Prof. Wiebenga, who kindly made an analysis of the boron we used in our neutron absorption experiments, found an impurity content of not less than 39 per cent. From this it might be concluded that the resonance energies hitherto published from our laboratory should be multiplied by $(0{\cdot}61)^2 = 0{\cdot}37$. As has been shown by the authors cited above, however, the neutrons suppressed by cadmium have in the mean an energy of 0·041 eV. instead of being really thermal neutrons, as was generally assumed hitherto. We used Rasetti's value of $\sigma_B = 4{\cdot}7\ E^{-1/2}$ cm.²/gm. [6], whereas the mean of the values found by the authors quoted in refs. 3, 4 and 5 is $6{\cdot}4\ E^{-1/2}$ cm.²/gm. We therefore conclude that our resonance energies should be multiplied by a factor $1{\cdot}85 \times 0{\cdot}37 = 0{\cdot}69$ to reduce them to their scale. This gives for the resonance energy of silver $0{\cdot}69 \times 8{\cdot}2 = 5{\cdot}7$ eV., in excellent agreement with their results (5·8 and 5·1 respectively).

In a paper soon to be published in *Physica* we shall deal in more detail with the other numerical data of our papers. Here it may be remarked that the general conclusions we arrived at remain valid, since the same correction has to be applied to all resonance energies.

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Hl. de Vries
H. Groendijk

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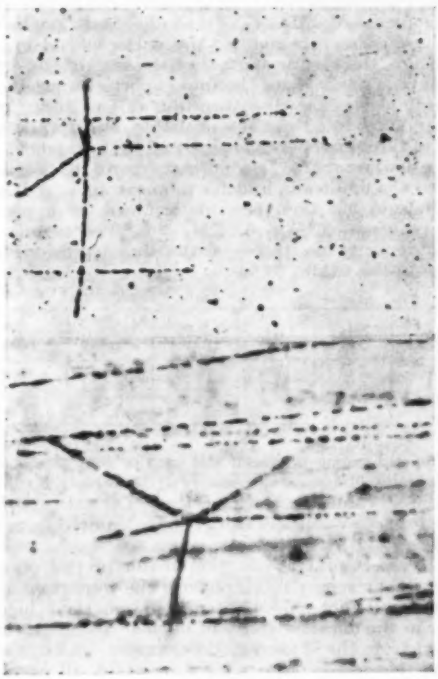
Disintegration of Nitrogen into Four α-Particles by Collision with Deuterons

We have recently exposed photographic plates, coated with the Ilford 'Nuclear Research' emulsions, to the 9 MeV. deuteron beam delivered by the Liverpool cyclotron. The deuterons were allowed to pass into the surface of the emulsion at a small angle of glancing incidence, and an exposure of less than 0·01 sec. was found to be sufficient to give a convenient number of tracks per unit area of the emulsion. In making measurements of the lengths of the tracks of the deuterons, we found, in addition to numerous forked tracks due to collision of deuterons with protons, examples of disintegrations produced by the entry of primary particles into nuclei of light elements, such as carbon, oxygen and nitrogen, present in the emulsion.



Two examples of a particularly interesting type of disintegration are shown in the accompanying photomicrograph. In the top photograph it will be seen that three deuterons have entered the emulsion, and that one of them has reacted with a nucleus and caused the emission of four particles. The lower photograph shows a similar event. The grain spacing in the tracks of the secondary particles is characteristic of α-particles and, since nitrogen is present in the gelatine, we attribute the disintegration to the reaction

$$N_7^{14} + H_1^2 \rightarrow 4\ He_2^4.$$

The possibility of this reaction was first mentioned by Cockcroft and Lewis[1], who observed a continuous distribution of α-particles from nitrogen bombarded

with deuterons; but they could not establish the fact of its occurrence in their experimental conditions.

We have now observed five events of this type, and the correctness of our interpretation can be proved by applying the principles of the conservation of mass-energy and of momentum. The lengths and spatial orientations of the tracks were determined, by the usual methods employed in the photographic technique, and the energy and momentum of the corresponding particles deduced from the range-energy curve for the emulsion. The units of momenta are calculated according to the formula $M = \sqrt{2mE}$, where E is the energy in MeV., and m the mass number of the nucleus.

For each particular disintegration we define a system of rectangular co-ordinates OX, OY, OZ, in which the origin O is taken to be the centre of disintegration and OX coincides with the direction of motion of the incident deuteron. The spatial orientations of the tracks enable us to determine the values of the momenta M_x, M_y, M_z, of the individual α-particles. In those cases in which all the particles end in the emulsion, the results show that the sum of the components M_y and M_z of the four α-particles produced in each particular disintegration differs from zero by amounts less than the probable error, while the sum of the components M_x is equal to the momentum of the deuteron, M_d. In some cases one of the particles leaves the emulsion, and its momentum, and hence its energy, has then been determined by applying the relations $\Sigma M_y = 0$, $\Sigma M_z = 0$. The results of measurements on three of the disintegrations are given in the table.

No.	ΣM_x	M_d	ΣE_α (MeV.)	E_d (MeV.)	Q (MeV.)
1	5·61	5·75	14·20	8·29	5·91
2	5·49	5·69	14·33	9·10	6·23
3	5·80	5·52	13·19	7·58	5·61

The difference between the sum of energies of the α-particles, ΣE_α, and the energy of deuterons, E_d, gives us the Q value for the reaction. The mean value, $Q = 5{\cdot}92$ MeV., differs from that calculated from the masses only by 0·40 MeV.

The successful application made in the present experiment serves to emphasize the important contribution which the photographic method has to offer in the detailed study of nuclear disintegrations. Apart from the Wilson cloud chamber, which is very slow, this is the only method in which all particles resulting in the disintegration can be recorded simultaneously. This, therefore, permits the application of the principle of the conservation of momentum in addition to that of conservation of energy. The scope of the method, for experiments of this type, is clearly very great.

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H. B. Burrows
W. J. J. Curry

George Holt Physics Laboratories,
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Feb. 20.

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Elementary Photochemical Process in Halides of Bivalent Metals

In 1929, Hilsch and Pohl[1] discovered an elementary photochemical process in the crystals of halides of *monovalent* metals, owing to a lucky choice of substances and to the application of an extremely subtle method. The assumption of the transition of the electron from the halogen ion to the ion of the metal in the halide crystals of monovalent metals was described first by Fajans[2] and also by Sheppard and Trivelli[3].

A similar elementary process takes place in the absorption of light in aqueous and alcohol solutions of alkali-halogen salts, as was stated by Franck and Scheibe[4] and confirmed by Butkow[5].

So early as 1937, one of us compared the long-wave edges of the spectra of calcium chloride, magnesium chloride and magnesium bromide crystals[6] with the spectra of the vapours[7] of these salts and directed attention to the fact that the shift of the long-wave edges of the first bands in the transition from the crystal to the vapour, as well as the corresponding shifts of the absorption bands of cæsium chloride, bromide and iodide, coincide (approximately) with the sublimation heats of the corresponding salts.

Proceeding from this fact, the hypothesis was set forth[8] that the elementary photochemical process taking place in the halide crystals of *bivalent* metals consists in the transition of an electron from the halogen ion X^- to the ion of the bivalent metal M^{++} with the formation of the subhalide (M^+X^-).

In order to check this hypothesis, consider the following cyclic process:

$$\begin{array}{ccccc} [M^{++}X_2^-] & \xrightarrow{[h\nu]^{cr}_{theor}} & [M^+X^-]X & \xrightarrow{Ad^0_X} & [M^+X^-] + (X)_a \\ \Big\downarrow Q^0_{MX_2} & & & & \Big\downarrow Q^0_{MX} \\ [M] + [X_2] & & \xrightarrow[\frac{1}{2}S^0_M + \frac{1}{2}D^0_{X_2}]{} & & [M] + \tfrac{1}{2}[X_2] + (X) \end{array}$$

where $[h\nu]^{cr}_{theor}$ denotes the quantum of radiant energy corresponding to the long-wave edge of the first absorption band of the MX_2 crystal; $Q^0_{MX_2}$ and Q^0_{MX}, the reaction heats of the formation of MX_2 and MX respectively at the temperature of absolute zero; S^0_X, and $D^0_{X_2}$ have the usual Born–Haber cycle meaning; Ad_X, adsorption energy of the halogen atoms X in the crystalline lattice of the subhalide $[M^+X^-]$.

From the cyclic process we have:

$$[h\nu]^{cr}_{theor} = Q^0_{MX_2} - Q^0_{MX} + \tfrac{1}{2}S^0_{X_2} + \tfrac{1}{2}D^0_{X_2} - Ad^0_X \quad (1)$$

The comparison of the experimentally determined first absorption bands of MX_2 crystals with the long-wave edges of these bands, calculated theoretically from equation 1, is given in the accompanying table and in Fig. 1, and has justified the above hypothesis with respect to *highly polar* compounds, MX_2.

Fig. 2 gives a schematical representation of the absorption spectra of crystals of the *weakly polar* compounds CdX_2 and ZnI_2.

With the help of equation 1, we have calculated the values of the energies $[h\nu]^{cr}_{theor}$ also for the weakly polar compounds, which correspond to the formation of a non-excited halogen atom (these values of the energy in Fig. 2 are represented by a vertical arrow, ↑).

We have calculated also the energy which corresponds to the transition of the electron from the

MX_2	$Q^0_{MX_2}$ [9]	$1/2\,S^0_{X_2}$	$1/2\,D^0_{X_2}$ [10]	Q^0_{MX} [11]	Ad^0_X	Long-wave edge		Position of maximum
						$[h\nu]^{Er}_{theor}$	$[h\nu]^{Er}_{exp}$	$[h\nu]^{max}_{exp}$ [12]
$BaCl_2$	8·97	—	1·27	2·65	0·05	7·54	6·9	7·7
$CaCl_2$	8·36	—	1·27	2·26	0·05	7·35	7·0	8·1
$MgCl_2$	6·62	—	1·27	0·78	0·05	7·06	7·05	7·6
$BaBr_2$	7·89	0·18	0·98	2·43	0·05	6·57	5·9	7·3
$MgBr_2$	5·33	0·18	0·98	0·43	0·05	6·01	6·0	6·5

(All values are in e-volts)

halogen ion to the ion of the metal, with the formation of an *excited* halogen atom:

$$[h\nu^*]^{Er}_{theor} = [h\nu]^{Er}_{theor} + A_X,$$

where A_X denotes the *excitation* energy of the halogen atom[13]. The values of the energy $[h\nu^*]^{Er}_{theor}$ in Fig. 2 are represented by circles, O.

A consideration of Fig. 2 leads one to the conclusion that the first absorption bands in weakly polar MX_2 crystals are connected with the transition of the electron from the halogen ion to the metallic ion with the formation of an excited halogen atom. It should be noted that in the absorption of light by weakly polar MX_2 molecules in the vapour state, the halogen atom is split off from the MX_2 molecule also in the excited state[14]; this is not so in the case of halides of bivalent lead, cobalt and nickel[15].

The absorption of light by the weakly polar MX_2 halides both in the gaseous and the crystalline state is thus accompanied by the formation of excited halogen atoms, which we believe to be connected with the fact that cadmium chloride, bromide and iodide and zinc iodide are characterized by *layer* crystal lattices, representing a type of lattice intermediate between the co-ordination and molecular types.

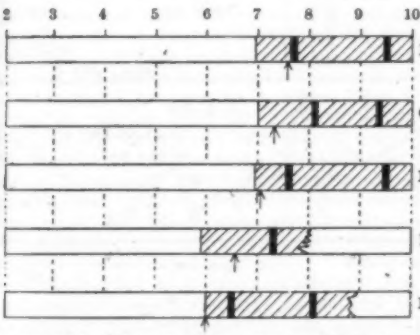

Fig. 1. Thick black line, maximum of absorption; hatched area, long-wave edge of spectrum; ↑, calculated value of $[h\nu]^{Er}_{theor}$

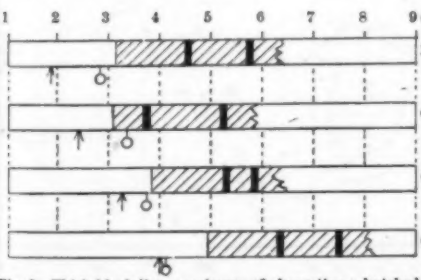

Fig. 2. Thick black line, maximum of absorption; hatched area, long-wave edge of spectrum; ↑ and O, calculated values of $[h\nu]^{Er}_{theor}$ and $[h\nu^*]^{Er}_{theor}$

In the case of highly polar MX_2 compounds (M = Ba, Ca, Mg), the first absorption band, both in the crystalline and the gaseous phase, is connected with the formation of non-excited halogen atoms.

Finally, intermediate cases are possible; for example, thallium chloride and bromide, in which, in the crystalline state (lattice of the CsCl type), the absorption of light leads apparently to the formation of non-excited halogen atom, while in the gas phase the molecule is photodissociated[16] with the formation of excited halogen atoms. This is due to the fact that, owing to the high ionization potential of the thallium atom, the polarizing action of Tl^+, according to Fajans' general theory of ionic polarization, is so large that the molecules of thallium chloride, bromide and iodide in the gaseous state are atomic (and not ionic).

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Ir. Wojciechowska

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Jan. 1.

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Oxidation Activity of Selenium Dioxide

In a recently published review on the mechanisms of oxidation, W. A. Waters[1] states that scarcely any evidence can be adduced for the mode of action of selenium dioxide. Since the discovery[2] of its specific oxidative activity, the interactions of selenium dioxide with more than three hundred organic compounds[3] of the most diverse character have been investigated: a common stoichiometric mechanism could scarcely be expected. There is, however, evidence which suggests the direction in which we should look for an explanation.

Many of the reactions have one feature in common, namely, the oxidation products are highly reactive substances; they must, therefore, have been formed initially in a low-energy state, otherwise they would

certainly have suffered further oxidative degradation. Spectrographic investigations[4] have shown that in the luminous, high-temperature oxidation of organic gases and vapours and of ammonia in selenium dioxide vapour, none of the electronic energy-levels in the product molecules is excited; the radiation emitted consists of diffuse bands and a continuous region in the visible (5620–4600 A.), with no trace of radiation in the ultra-violet. These bands are probably due to selenium or possibly SeO molecules. The phenomenon indicates that when the activated reaction complex breaks down, the greater part of the energy of the reaction and the activation energy remains with the selenium. It is not improbable that similar phenomena occur in the condensed phase at somewhat lower temperatures, where visible radiation would not be expected.

The unique oxidative reactivity of selenium dioxide probably depends upon this electronic property of the selenium. The structural characteristics of the organic molecule undergoing oxidation will govern the formation of the necessary unstable intermediate compound or activated complex.

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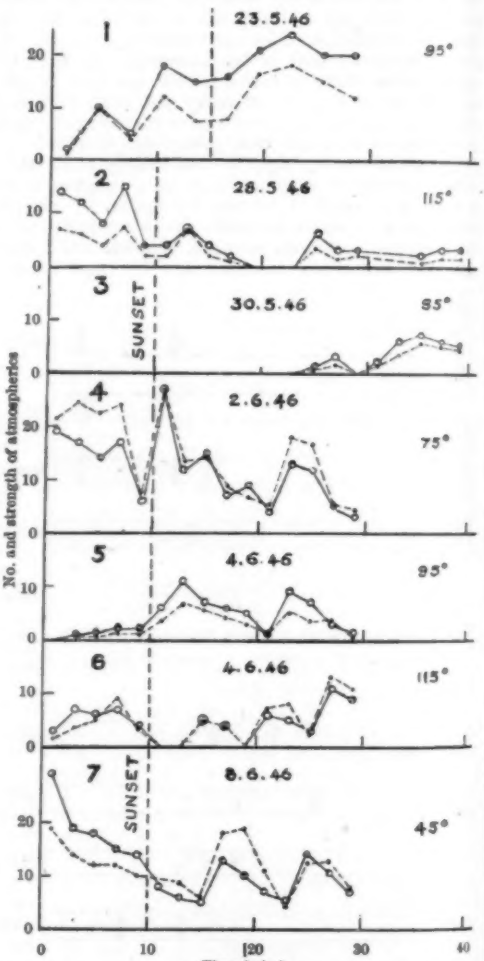
Location of Thunderstorm Centres from Directional Observations of Atmospherics During Sunrise and Sunset

It has been known for many years[1] that there are anomalies in the number and strength of the *distant* atmospherics observed during the sunrise and the sunset periods. Investigations[2] in this laboratory on distant atmospherics on high and medium radio frequencies showed unmistakable maxima during sunrise and sunset. Previously, Potter[3] had observed similar effects. The effect of sunset on atmospherics was also reported by Subba Rao[4]. Besides Potter and Namba[5], Khastgir[6] recently offered an explanation of the sunrise and sunset effects observed. The object of the present communication is to show that on this theory a simple method can be devised for the location of a thunderstorm centre which gives rise to atmospherics by observing the time of occurrence of the maximum in the strength of the atmospherics, when the distant thunderstorm prevails over a period of time covering sunrise or sunset. The results of some directional observations of atmospherics at about sunset are also given in this connexion.

From a distant thunderstorm centre in the troposphere, the atmospheric pulse of waves is usually reflected from the ionosphere and reaches the receiving point. In the small hours of the morning, it is evident, the intensity of the down-coming waves, originally coming from the distant source of atmospherics, increases gradually with the slowly decreasing ionization in the *E*-layer until, on the incidence of the solar rays, at sunrise, there is a great increase in the ionization, causing a large fall in the intensity owing to greater absorption in the layer and also to greater deviation of the rays due to higher electron concentration. This causes a maximum in the strength of the atmospherics about the time of sunrise. Before sunset, again, the intensity of the down-coming waves gradually increases, due to a continuous decrease in ionospheric absorption, until at the instant of the withdrawal of the solar rays at sunset the intensity suddenly falls. This is because when the ionizing solar rays are withdrawn there is a perceptible decrease in the *E*-layer ionization, and the down-coming waves are much less deviated and necessarily fail to reach the receiving point. This gives a maximum in the strength of the atmospherics about sunset time. Afterwards, however, the smaller ionospheric absorption asserts itself, causing at first a slow decrease of intensity and ultimately an increase.

The work on the early morning increase of *E*-layer ionization by Mitra and his co-workers[7] has shown that the ionization begins to increase, not when the early morning solar rays strike the *E*-layer by grazing the earth's surface, but when the rays strike the layer by grazing the surface of the ozonosphere at a height of 35 km. above the earth. The sun's rays, in order



Direction in degrees with reference to the north – south line. —o—, No. of atmospherics in 2 min.; - - -●- - -, total strength of atmospherics in 2 min.

to produce ionization in the E-layer, should, therefore, pass over the ozone region, so that radiations of the shorter wave-lengths will not be absorbed by the ozone. Keeping this conclusion in view, the time of occurrence of the increase of ionization in the E-layer by the sun's rays at dawn or of the decrease of ionization when the solar rays are withdrawn at dusk can be found with reference to the ground sunrise and sunset times. This would correspond to the time of occurrence of the maximum of atmospherics observed about the time of sunrise or sunset.

If the angle between the two tangents on either side of the ozonosphere from the point of ionospheric reflexion is denoted by $(180° - \varphi)$, it can be shown that the difference between the instant of ground sunrise or sunset and the time of occurrence of the atmospherics maximum is given by : $\Delta T = 4\varphi \pm (l_s - l_r)$, where l_s and l_r denote the longitudes of the source of atmospherics and the receiving point. The value of φ in the above relation can be calculated approximately from the known values of the heights of the E-layer and the ozone layer and from the location of the receiving point. If now the latitude λ_r and longitude l_r of the receiving point are known, the latitude λ_s and the longitude l_s of the source of atmospherics can be easily determined from the observed value of ΔT, remembering, however, that the observed angle of arrival of the atmospherics is given by $\tan \alpha = \dfrac{\lambda_s \sim \lambda_r}{l_s \sim l_r}$. Having thus obtained the location, the distance of the thunderstorm centre can be easily found.

A few typical experimental results on 1,000 metres on the subject are shown in the accompanying graphs. Here the number and total strength of the atmospherics (in arbitrary units) for 2 min. are plotted against time for specified directions. One distinct case of successive double reflexion simultaneously occurring with the usual single reflexion between the source of atmospherics and the receiving point is shown in curve No. 6, where there are three peaks at regular intervals. The location of the source of atmospherics in such cases is obtained with reference to the middle peak. It is likely that curves 5 and 7 represent two other similar cases, where possibly the farthest of the three successive peaks is not observed. The location and the distance of the thunderstorm centres for the cases illustrated are given in the accompanying table. The experiments were performed with the cathode-ray tube D.F. equipment of the Council of Scientific and Industrial Research (India), to whom our thanks are due.

No.	Location	Distance in miles	No.	Location	Distance in miles
1	(a) 100·65° E. 22·8 N.	646	4	(a) 97·9° E. 25·7 N.	497
	(b) 78·9 E. 22·7 N.	744		(b) 101·9 E. 26·8 N.	755
	(c) 81·65 E. 22·9 N.	563		(c) 103·9 E. 20·1 N.	896
2	(a) 96·9° E. 20·7 N.	473	5	97·9° E. 23·0 N.	484
	(b) 102·9 E. 17·9 N.	910	6	98·9° E. 23·3 N.	542
	(c) 77·9 E. 17·9 N.	910			
3	(a) 91·4° E. 23·8 N.	118	7	96·9° E. 30·2 N.	605
	(b) 95·9 E. 24·2 N.	424			

Signal strength observations at Dacca[9] of the Calcutta short-wave station during the sunset period showed a maximum at the time predicted by the present theory of sunrise and sunset effects.

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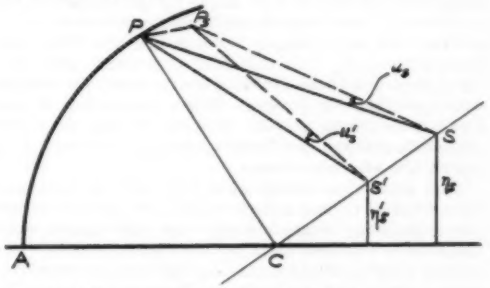
An Optical Magnification for Finite Objects

If N,u,η are the refractive index, the paraxial angle, and the size of object respectively, and dashes denote these quantities in the image space, then the magnification formula,

$$m = \frac{\eta'}{\eta} = \frac{Nu}{N'u'}, \quad . \quad . \quad . \quad (1)$$

is valid for limiting by small values of η only, with the same condition applying to the invariance of the quantity $Nu\eta$ throughout the system. It is, however, possible to derive a similar expression which is valid for finite object sizes.



In the diagram, PS,PS' are incident and refracted principal rays, S,S' being the foci of close sagittal rays P_sS, P_sS'. It is known that S,S' lie on the auxiliary axis $CS'S$. Let the heights of S,S' be η_s,η_s'; these will be called sagittal objects and image heights. Then the magnification is

$$m = \frac{\eta_s'}{\eta_s} = \frac{CS'}{CS} = \frac{s' \sin I'}{s \sin I},$$

where $s = PS$, $s' = PS'$; $I = \angle SPC$, $I' = \angle S'PC$. If now the sagittal paraxial angles $u_s = \dfrac{PP_s}{s}$, $u_s' = \dfrac{PP_s}{s'}$ be introduced, one has

$$\frac{\eta_s'}{\eta_s} = \frac{Nu_s}{N'u_s'}.$$

Thus η_s', η_s are related by the sagittal magnification $m_s = \dfrac{Nu_s}{N'u_s'}$, and the quantity $Nu_s\eta_s$ is invariant irrespective of the magnitudes of η_s and η_s'.

It is also easy to prove the results by noting that the sagittal image heights describe object and image circles on rotation of the diagram about AC. The magnification of each element of the object circle so obtained is the same and equal to m_s. Thus the perimeters of the two circles being related by the sagittal magnification, so must their radii be similarly related.

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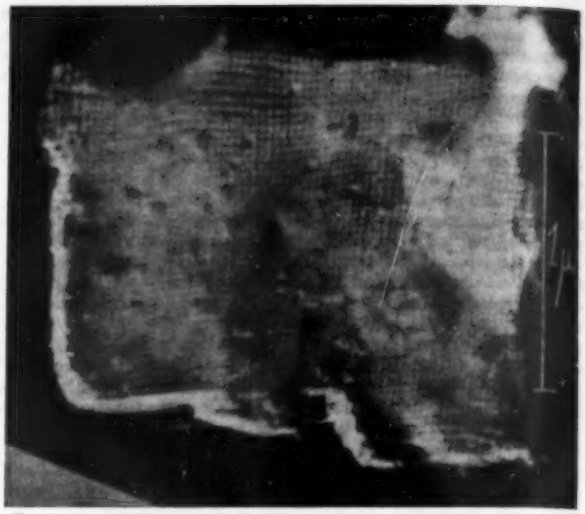
Electron Microscopy of Tobacco Necrosis Virus Crystals

Electron microscopy has shown the regular way in which the elementary particles, or molecules, of the southern bean mosaic virus are arranged in its crystals[1]. Not all crystallizable viruses are equally easy to examine in this fashion; but we have found that satisfactory photographs can be obtained of single crystals of a strain of the tobacco necrosis virus. They differ from the bean mosaic virus electron micrographs in a number of interesting and instructive ways.

The crystals were of microscopic size obtained from a purified solution of a newly isolated member of this group of viruses[2], prepared by high-speed centrifugation followed by salt precipitation. Replicas[3] of a dilute suspension of the crystals in half-saturated magnesium sulphate were made by spreading a small drop on a clean microscope slide, coating the dried spread with an obliquely evaporated gold film, reinforcing the gold with thin collodion and floating the combined film from the slide on to water for cutting and mounting on screens. The preparations in this form were given a final vertical deposit of a few angström units of beryllium to enhance their stability under the electron beam.

The molecular array over the face of a typical microcrystal of this necrosis virus can be seen in the accompanying reproduction. In the many fields examined, crystals have always been covered with a haze which probably is to be attributed to impurities remaining in the preparation. Though this interferes with photography at the highest magnifications, it does not obscure many features of the crystalline structure. The molecular net of nearly all the necrosis virus crystals that have been photographed suggest, as does the one shown here, a frayed piece of wire screening. The extensive irregularities of these nets have prevented very accurate determinations of interparticle distances. Nevertheless, measurements across 10–20 molecular rows in undisturbed regions indicate that the same particle separation, *c.* 275 A., prevails in both the vertical and the horizontal directions. In the bean mosaic crystals the separation is nearly 50 per cent greater in one direction than in the other. The rows of particles are approximately at right-angles, but the net is not strictly cubic. In the crystal illustrated here, its obtuse angle is *c.* 95°.

The photographs made thus far do not establish with certainty the way succeeding layers of particles overlie one another to build up a crystal. Most of the evidence points to the lattice being simple, though a body-centred arrangement cannot yet be excluded.



Electron micrograph showing the particle arrangement over the face of a single tobacco necrosis virus crystal. × *c.* 38,000

Many of the thinnest deposits probably were formed as the crystal suspension dried on the slide. Their particles, too, are in a square network. Regular arrangements having no more than a dozen or so particles on a side are also not uncommon. This ability of the necrosis virus to crystallize directly from solution should make it especially valuable for use in studies of the first steps in crystal formation.

The electron micrography of this virus is being continued; its results will be described in more detail elsewhere.

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Alloxan Diabetes and the Kidney in the Rat

Jimenez-Diaz, Grande-Covian and De Oya[1] have reported recently that dogs in which the vessels of both kidneys were clamped prior to and for ten minutes following the intravenous injection of 100 mgm./kgm. of alloxan failed to develop either the hyperglycæmia or the uræmia of the controls in which the clamping was omitted. On the basis of this experiment they postulated the existence of some factor in the kidney with which the alloxan must come in contact before it can exert its full diabetogenic effect.

Alloxan is known to exert a specific toxic action on the beta cells of the islets in many species[2]. It was felt that should there be a chemical factor in the kidney necessary to mediate the toxic effect, it would

be present in all those species in which the diabetogenic action was observed. We chose the rat to test the hypothesis.

Male and female adult hooded rats, of a strain bred in this laboratory, weighing between 175 and 250 gm., were fasted for twenty-four hours, then operated on under ether anæsthesia. In the control group the abdomen was opened, the inferior vena cava exposed, and injection of 100–175 mgm./kgm. alloxan in aqueous solution made into this vein. In the experimental group, the kidneys were exposed, the pedicles dissected free and the vessels clamped prior to the injection. The clamps were then left in place for ten minutes as described by Jimenez-Diaz and collaborators in their original report. Following this treatment the animals were returned to their cages and allowed food and water *ad lib.* Blood-sugar determinations were made on tail-vein blood samples obtained from the survivors at 24 and 48 hours following the injection. A condensation of the results is shown in the accompanying table; 48-hour blood sugars only are tabulated as the 24-hour and earlier samples were found to be erratic in both groups. Blood-sugar values greater than 130 mgm. per cent were listed as hyperglycæmic in this summary as the sugar method used (Somogyi and Nelson[3]) gives low values corresponding to true sugar. However, only two rats fell into the group with blood sugar 130–150 mgm. per cent; the remainder all displayed levels higher than 250 mgm. per cent. No differences were noted due to different treatment doses used, namely, 175, 150, 140 and 100 mgm./kgm., and all the results are included together in the table.

	Kidneys clamped		Kidneys not clamped	
	No. of rats	Per cent	No. of rats	Per cent
Total	36	100·0	18	100·0
Survivors at 48 hr.	22	61·1	12	66·7
Hyperglycæmic at 48 hr.	18	50·0 81·7*	11	61·1 91·6*

* Percentage of survivors.

Differences between the two groups were not found to be significant when tested with the fourfold table and Fisher's χ^2 method.

A further group of three rats was nephrectomized, following which 275 mgm./kgm. alloxan was injected intraperitoneally in aqueous solution. At 24 hours the animals were sacrificed, blood sugars determined and pancreases sectioned and stained. Typical necrotic changes, disappearance of granules, pyknosis, shrinkage of cytoplasm, were seen in the pancreases of all three animals, although the blood-sugar levels at the time of death were 58, 138 and 216.

A possible mechanism for the effects observed by Jimenez-Diaz and collaborators was suggested to me during the course of the above experiments. Goldner[2] has shown that if a portion of the pancreas is clamped off for as little as five minutes during and subsequent to the injection of alloxan in rabbits, the clamped portion fails to show histological signs of damage while the unclamped portion displays typical necrosis. During the dissection of the renal pedicle in some of the rats, a temporary blanching of the pancreas was observed. This was thought to be due to reflex vasoconstriction. If this same mechanism operates in the dog, only to a more marked degree, it might afford sufficient curtailment of pancreatic blood flow while the alloxan was being inactivated to protect the islets from the toxic action.

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The Renal Factor in Alloxan Diabetes

JIMENEZ-DIAZ *et al.*[1] have recently reported their failure to induce diabetes in dogs by the intravenous injection of alloxan when both renal pedicles were clamped immediately before and for ten minutes after its administration. They concluded that "the contact between alloxan and the kidney is apparently necessary for the display of the full diabetogenic effect". We have repeated these experiments in rabbits and find that alloxan diabetes of the usual degrees of severity is produced when the kidneys are excluded from the circulation by clamping of the renal pedicles.

In our experiments, white domestic rabbits varying in weight from 1·9 to 2·9 kgm. were used. In each case, alloxan in a 5 per cent aqueous solution was administered intravenously in a single dose of 200 mgm. per kgm. of body-weight. Control and experimental animals were always grouped together and injected with the same freshly prepared solution of alloxan. Preliminary study established the fasting blood-sugar level for each animal. Before and for 48 hours after the injection of alloxan, the animals were allowed food *ad lib.*, and non-fasting blood-sugar levels were determined at intervals beginning at 2 hours and thereafter at 4, 8, 12, 16, 20, 24 and 48 hours after the administration of alloxan. Determinations of the fasting blood-sugar levels were made at 72 and 96 hours.

Eight of the fourteen rabbits employed in this experiment were normal control animals treated with alloxan. Six of these eight rabbits became diabetic and two were resistant to the diabetogenic action of alloxan. The blood-sugar content of the diabetic animals varied from 360 to 640 mgm. per cent. Two of the animals that became diabetic had been injected with alloxan while anæsthetized with nembutal and ether. A ninth animal was subjected to similar anæsthesia and, in addition, to the operative procedure of bilateral renal pedicle clamping for 12 minutes with clamps that were known by previous experience to produce complete obstruction of renal blood flow as proved by the absence of bleeding when the renal pedicle was transected. No alloxan was administered to this animal. The blood-sugar returned to a normal level within 8 hours after this operative interference, and remained so thereafter. The remaining five animals were subjected to an identical operation under the same general anæsthesia and, when both renal pedicles were clamped, alloxan was administered. The clamps were allowed to occlude renal blood flow for ten minutes after the end of the injection of alloxan, and then were removed with the re-establishment of renal circulation. Three of the five animals thus treated became diabetic as judged by the fasting blood-sugar level after 96 hours, these levels being 352, 420 and 520 mgm. per cent respectively. It was noted that both control and experimental animals exhibited the usual variability and irregularity of blood-sugar content during the 24-hour period immediately following the administration of alloxan.

In order to test further the existence of the diabetic state, glucose tolerance tests were done several days before and 72 or 96 hours after the injection of alloxan. The test dose consisted of 1·5 gm. of hydrated glucose per kgm. of body-weight, given intravenously in the fasting state as a 20 per cent aqueous solution. The fasting blood-sugar levels at 72 and 96 hours, together with the results of the glucose tolerance tests, demonstrated that all animals that had received alloxan, whether apparently resistant to its action or not, showed a more or less marked impairment of glucose metabolism. This observation was further confirmed by the detection of an alimentary glycosuria in the alloxan-treated animals that had normal fasting blood-sugar levels, and this in turn was found to occur during periods of abnormal postprandial hyperglycæmia.

Some of the animals died or were killed on the fourth or fifth day of the experiment, but the blood-sugar levels of those that survived were followed for varying periods up to four weeks. While in general the level of the blood sugar at 72 and 96 hours was a reliable index of the subsequent course, nevertheless, in one rabbit treated with alloxan alone, and in two subjected to clamping of the renal pedicle and to alloxan injection, there was a gradual reduction of the fasting blood sugar to normal levels. On the other hand, one rabbit that appeared to be non-diabetic 96 hours after clamping of the renal pedicle and alloxan injection became markedly diabetic on the twelfth post-operative day, and was killed on the sixteenth day when the blood-sugar level was 495 mgm. per cent. In our previous experience with alloxan diabetes in the rabbit, we have encountered such anomalies not infrequently.

In histological sections of the pancreas of animals given alloxan while the renal pedicles were clamped, there was found evidence of recent necrosis of the beta cells of the islets of Langerhans indistinguishable from that seen in control animals treated with alloxan alone. Moreover, identical necrosis of the islets of Langerhans was observed in two rabbits injected with the same intravenous dose of alloxan as the animals described above, but immediately after bilateral nephrectomy.

It is obvious that our observations in the rabbit are distinctly at variance with those of Jimenez-Diaz *et al.* in dogs. While the preliminary data that we have presented are quite inadequate to demonstrate that exclusion of the kidney from the circulation has no effect whatever upon the development and course of alloxan diabetes, nevertheless our observations demonstrate clearly that it is possible to produce in the rabbit necrosis of the islets of Langerhans and the development of a typical diabetic state by the intravenous injection of alloxan while the renal circulation is arrested by clamping of the renal blood vessels. We conclude, therefore, that the continuance of renal circulation during, and for a short time after, the injection of alloxan is not essential to the diabetogenic action of alloxan in the rabbit.

It is a pleasure to acknowledge that this investigation was assisted by grants-in-aid from the Cooper Fund of the Faculty of Medicine, McGill University, and from the National Research Council, Canada.

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Practical Three-Hour and Two-Hour Cylinder-Plate Assays for Penicillin

In the course of experiments designed to study cytochemical changes which occur in susceptible cells under the influence of penicillin, we applied various stains and reagents to agar plates prepared as for the standard *F D A* cylinder-plate assay, which is essentially similar to that recommended by Schmidt and Moyer[1]. The technical procedures employed and the cytochemical observations are being reported in detail elsewhere, and are interpreted in terms of an equilibrium between sulphhydryl and disulphide groups[2]. It will suffice here to state that thresholds for a number of chemical groupings were shown to exist at the boundaries of zones of inhibition on plates seeded with *Staph. aureus NRRL.* strain No. 313, or with the rough form of *B. subtilis NRRL.* strain No. *B*-558, and afterwards exposed to penicillin. It is well known that these test organisms are most sensitive to penicillin when they are in the logarithmic phase of growth. Therefore, we found it advantageous to pre-incubate the seeded plates for three hours before adding the solutions to be tested[3]. When this is done, a secondary incubation period of three hours for *Staph. aureus* or of two hours for *B. subtilis* is sufficient for the minute colonies developed during primary incubation to react to the diffusion of penicillin so that the thresholds can be located clearly by suitable techniques.

All the techniques which we have used that sharply delineate the zones of inhibition agree in locating the threshold at the same distance (within the limits of experimental error) around a cylinder from which a given concentration of penicillin has been permitted to diffuse for a given length of time. Therefore, any of these procedures can be applied as practical tools for completing assays of penicillin within two or three hours from the time the unknown solution is placed on test. A rapid technique, involving impregnation of the plates with silver and subsequent physical development, has been shown to give assay values that agree closely with those obtained by the longer standard method, requiring sixteen hours of incubation and diffusion[3]. Therefore, plates processed

Diameters of zones of inhibition on plates treated with different reagents

A. Three-hour *Staph. aureus* plates	Units penicillin/c.c. 0·5	1·0	2·0	4·0	8·0
Reagent:					
Sulphite fuchsin (Schiff's)	12·3	13·0	15·0	16·3	17·3
Ferricyanide, then ferric sulphate	11·5	13·5	15·0	16·5	17·5
Azo-coupling reagent	12·3	13·3	14·5	16·3	17·0
Bromo-cresol purple	11·5	14·0	—	16·5	17·5
Phenolsulphone phthaleine	11·5	12·3	—	15·5	17·0
Nile blue	11·0	12·0	13·5	16·0	17·0
Janus green	12·0	13·0	14·0	15·5	17·0
Methyl green	12·0	13·0	13·5	15·0	17·0
Safranine O	11·0	12·0	—	15·5	16·5
Average for the day: Observed	11·70	12·90	14·30	15·90	17·10
Calculated*	11·74	12·93	14·25	15·77	17·39
Average for standard (physical development)	11·70	12·80	14·50	16·00	17·30
B. Two-hour *B. subtilis* plates					
Reagent:					
Sulphite fuchsin (Schiff's)	11·60	—	13·40	14·40	15·70
Ferricyanide, then ferric sulphate	10·25	11·80	13·50	14·50	16·00
Cadmium acetate	11·0	—	—	14·70	16·25
Cobalt nitrate	10·80	11·80	13·25	14·50	15·50
Average for the day: Observed	10·92	11·80	13·38	14·53	15·86
Calculated*	10·77	11·96	13·13	14·44	15·87
Average for standard (physical development)	10·90	11·80	13·10	14·40	15·70

*Based on a linear log diameter – log concentration function.

by physical development are used as standards of reference in the accompanying table. Advantages of the methods tabulated above over the silver impregnation–physical development technique are their still greater simplicity and rapidity. All the methods recorded are potentially useful and have been employed frequently in our laboratory.

Whereas processing the assay plates by the technique of physical development previously described may require fifteen minutes, flooding them with 1 or 2 per cent ferricyanide, draining, and flooding with 1 per cent ferric sulphate reveals the zones within two or three minutes; the colour reactions which outline the areas of inhibited growth develop immediately when plates are flooded with the Schiff's reagent, the azo-coupling reagent, or any of the dyes listed. The rapid methods tabulated above have the common advantage that, with the short time allowed for diffusion of penicillin, the reference curve obtained by plotting log diameter against log concentration is linear over a useful range more than twice that of the present standard method.

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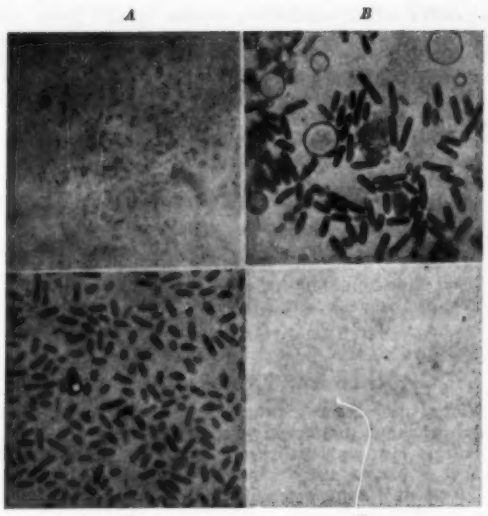
Nucleotide Metabolism of Bacteria and the Bacterial Nucleus

OWING to the content of purine and pyrimidine rings of the nucleic acids, they exhibit a specific absorption within the ultra-violet range with an absorption maximum at 2600 A. This makes it possible to demonstrate directly the presence of nucleotides in cells. The quantitative conditions can be studied by means of the technique devised by Caspersson and co-workers. A method has now been worked out in which the order of magnitude of the nucleotide content in bacteria can be determined by photometry of microphotographs taken at 2570 A.

Both Gram-negative and Gram-positive bacteria have been investigated (*Escherichia coli*, *Aerobacter aerogenes*, *Proteus vulgaris*, *Flavobacterium*, *Bacillus cereus*, *Staphylococcus albus*, *Streptococcus fæcalis*, *Spirillum rubrum* and *Corynebacterium diphtheriæ*), and a series of investigations was carried out for each type of bacterium; about forty organisms were used.

In all cases great changes took place in the nucleotide content during the early phase of growth, the nucleotide content reaching a maximum during the end of the lag phase or the beginning of the logarithmic phase. The nucleotides of the individual bacterium underwent an increase corresponding to five to ten times the original content. A general conception of the variations is obtained from the accompanying reproduction, which shows the content of absorbing substance in *E. coli* on four different occasions. The contrast obtained in the positive is a relative measure of the nucleotide concentration.



PHOTOGRAPHS OF *E. coli* TAKEN AT 2570 A. *A*, INOCULUM; *B*, MIDDLE OF LAG PHASE; *C*, BEGINNING OF LOGARITHMIC PHASE; *D*, PHASE OF DECLINATION

In the case of *E. coli*, where a nitrogen analysis was made in one experiment, it was found that, on the whole, the total amount of nucleic acid and protein followed the same course. Further, it appears that there was a connexion between the length of the generation time and the nucleotide metabolism. The amount of nucleic acid newly formed during the generation was in inverse relation to the generation time. However, this did not hold good for the first generation, during which the new formation was especially pronounced. The divergence for this generation and the lag phase included in it may be interpreted as an expression of a diffusion or a secretion of protein, the formation of which has been shown to presuppose the presence of nucleotides (Caspersson).

The increase in nucleotides and in the volume of the individual bacterium occurred during the same period. The volume variations were especially pronounced for *B. proteus*, in which the increase in volume and nucleotide content ran parallel and were in inverse relation to the size of the inoculum. The increase in size could be ascribed mainly to an uptake of water.

The observations made by ultra-violet microspectrography and Feulgen–Rossenbeck's nuclear reaction indicated that the bacteria have two nucleotide systems connected with bacterial growth, one of ribose and the other of ribodesose type. In common with a number of other research workers, we were able to prove the presence of Feulgen-positive structures which evidently undergo fission in connexion with bacterial fission. The formation of ribose nucleotides appears to start from ultra-violet-absorbing grains, which in connexion with the intense increase of nucleotide disappeared in the diffusely absorbing bacteria. We consider that we have gained support for the assumption that bacteria have a nuclear mechanism the function of which agrees in principle with that met with in metazoan cells. The two systems form a functional unit, but are not combined in a morphological unit. The ribodesose

organella which undergoes fission would form an equivalent to the euchromatin of the metazoan cell; the ribose system would be looked upon as a functional counterpart to the heterochromatin. From the former the formation of gene protein is induced; the latter controls the formation of the protein of the cell body. This latter process is reflected in great changes in the content of ribose nucleotides in the individual bacterium.

A detailed account of this work will be published shortly.

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Feb. 28.

Cytochemical Effects of Œstradiol

The œstrogenic action of certain carcinogenic hydrocarbons such as 3:4 benzpyrene and 5:6 cyclopentane-1:2 benzanthracene and the carcinogenic effect of œstrogenic hormones (see recent review by Greenstein[1]) suggested to us a comparison of the cytochemical effects of œstradiol on the vaginal wall of mice with the primary effects of methylcholanthrene on the epidermis studied in detail by Cowdry and his collaborators.

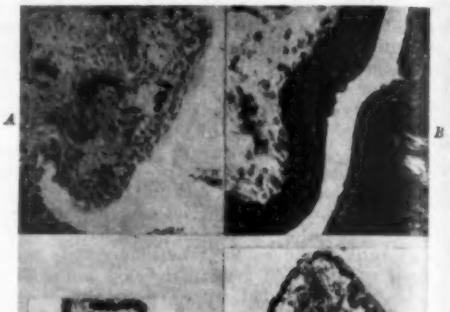
As early as 24 hours after the injection of 10 mgm. œstradiol into a mouse, ovariectomized one month previously, the proliferating vaginal wall shows a very marked increase in alkaline phosphatase activity, especially in the cytoplasm of the cells (technique of Gomöri[2]). This observation was confirmed by *in vitro* determinations of phosphatase activity in vaginal extracts, which show that orthophosphate liberated in three hours from sodium glycerophosphate increases, for example, from 430 γ to 1,500 γ P per mgm. protein nitrogen. This increase in alkaline phosphatase activity is accompanied by a large increase in cytoplasmic ribonucleic acid detected by the ribonuclease technique of Brachet and confirmed by estimations following Schneider's technique[3].

These two phenomena are comparable to those which have been found to occur in mouse epidermis after methylcholanthrene treatment (Biesele[4]).

An increase in alkaline phosphatase activity of the same order of magnitude is shown in the uterus, principally in the circular muscle layer[5]. In this organ, also, there is a parallel increase in the concentration of ribonucleic acid. One can observe regularly a slight increase in alkaline phosphatase activity in the liver, but no increase in brain, kidney or blood plasma.

Brachet and Jeener[6] have put forward the hypothesis that the increase in phosphatase activity observed in the nuclei of regenerating liver may be related to the increase in thymonucleic acid phosphorus turnover. A similar hypothesis does not seem to be applicable to variation in cytoplasmic phosphatase activity. For example, the ribonucleic acid metabolism in pancreas must be very high (Caspersson[7]), notwithstanding the fact that phosphatase content of this organ is very low.

On the other hand, the data given in this report are in agreement with the idea that an increase in alkaline phosphatase is not parallel to general protein synthesis, but only to the synthesis of fibrous proteins (see review by Moog[8]). Keratin is rapidly synthesized by the vaginal wall under the influence of œstradiol. Some preliminary data lead us to believe that myosin synthesis occurs in the uterus under the same conditions. The absence of any increase of phosphatase activity in the crop of the prolactin-injected pigeon can well be explained by the absence of any histological signs of keratin or collagen fibre synthesis during the growth of its mucosa. Finally, we note the similarity between effects of œstradiol on vaginal and uterine phosphatase and those of androgen hormones on the prostate (Gutman[9]).



A and *C*, vaginal epithelium and uterus of a castrated mouse; *B* and *D*, same tissues 24 hours after injection of 10 γ œstradiol. Sections treated simultaneously by Gomöri's technique

R. Jeener

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University of Brussels. Feb. 22.

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Synthesis of Methionine and Similar Amino-Acids

Of several recent syntheses of *dl*-methionine, that commencing with γ-butyrolactone[1] is relatively long, while others[2] are additionally inconvenient in that they employ methyl-β-chloroethylsulphide, a vesicant intermediate. It seems, therefore, desirable to state that the following series of reactions has been found to afford an overall yield of *dl*-methionine of 29 per cent (that is, based on acrolein), and to be free from disadvantages such as those mentioned above:

$$CH_2:CH.CHO \xrightarrow{MeSH} CH_2(SMe).CH_2.CHO \xrightarrow{HCN}$$

$$CH_2(SMe).CH_2.CH(OH)CN \xrightarrow{NH_3/EtOH}$$

$$CH_2(SMe).CH_2.CH(NH_2)CN \xrightarrow[\text{at } 100°]{\text{Conc. HCl}} dl\text{-methionine.}$$

Commercial acrolein containing a trace of triethylamine was treated with methylthiol to give

β-methylthiopropionaldehyde, which, after isolation, was allowed to react with liquid hydrogen cyanide in presence of a small amount of potassium cyanide. The crude cyanohydrin was converted at 80° into the corresponding aminonitrile, which was isolated as its oxalate and hydrolysed to methionine. It may be recalled that β-methylthiopropionaldehyde has previously been obtained from acrolein[2], though apparently only under obscure conditions or in small yield. Moreover, the methylthioaldehyde has been converted by what are in principle the steps outlined above into *dl*-methionine[4], but low yields seem to have given the premature impression that this synthesis is of little practical value.

In the present work similar reactions have also been used to prepare analogous acids such as ethionine, α-amino-γ-benzylthio-*n*-valeric acid, and α-amino-γ-benzylthio-γ-methyl-*n*-valeric acid in satisfactory yield. The last-mentioned compound has been debenzylated to give α-amino-γ-thio-1-γ-methyl-*n*-valeric acid, an analogue of penicillamine, the degradation product of the various penicillins.

A full account of these syntheses has been submitted for publication in the *Journal of the Chemical Society*.

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[1] Livak, J. E., Britton, E. C., Vander-Weele, J. C., and Murray, M. F., *J. Amer. Chem. Soc.*, **67**, 2218 (1945).
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[3] Kaneko, T., and Mii, S., *J. Chem. Soc. (Japan)*, **59**, 1382 (1938); *Chem. Abs.*, **33**, 2106 (1939). Rothstein, E., *J. Chem. Soc.*, 1560 (1940).
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Origin of Erythrocytes

It seems desirable to utter a caveat in reference to Dr. S. H. Wajda's communication on the origin of erythrocytes from striated muscle[1]. During the last two years, many hundreds of sections of muscles previously traumatized by various means have been studied in great detail in this Department. In view of the suggestion often made in the past (and particularly in view of the recent work of Chèvremont) special search has been made for convincing evidence of the transformation of muscle fibres into various types of connective tissue cells. Unfortunately, the histological picture is usually extremely confused in the traumatized area at first and, unless the sections are studied with a critical eye, it is possible to mistake histiocytic and other phagocytic elements for actual transitional forms between disintegrating muscle cells and various connective tissue cells. Because of these difficulties, it has been reluctantly concluded that this type of material is really not adequate for the solution of such a problem. In some cases it can be certainly demonstrated that the appearance seen under the microscope suggesting a transformation of a muscle fibre into histiocytes is quite illusory (although, of course, this does not preclude such a possibility).

It seems not improbable that the suggested transformation of striated muscle fibres into red blood corpuscles (a process which is referred to by Dr. Wajda as 'instantaneous') is also based on such illusory appearances. One of the members of this Department has been engaged for several months in the study of living striated muscle fibres by micro-dissection, and has often watched them *in vivo* for several hours after traumatization. In no case has any process been observed which is even remotely similar to that described by Dr. Wajda.

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Nature, **159**, 254 (1947).

The working hypothesis on blood formation on which Prof. Le Gros Clark comments was put forward because the wealth of observation behind it could not fit any established views on hæmopoiesis, and because some general statement was warranted, if for no other reason, as a basis for further experiment. My views are based both on extensive cytological observation and on experimental evidence which will be fully discussed elsewhere.

I do not agree that the histological picture of traumatized muscle is so confused as to defy critical examination. The architecture of striated muscle is much more regular than that of loose connective tissue, a tissue of choice in the study of inflammation, and a cytologist should not encounter any great difficulty in following its cellular changes.

Judging from his own published work on muscle, Prof. Le Gros Clark's studies have been neither concerned with muscles working at the time of fixation, nor with acute changes in them, nor, indeed, with blood formation. This might, in part, account for his failure to confirm my observations. At the same time, I might direct attention to the fact that there is a photomicrograph (Fig. 23) in his latest paper which clearly shows cells budding off from an injured muscle fibre, and the process itself is described in some detail in the text. Prof. Le Gros Clark decided, however, that the fate of these new elements could not be determined.

It is necessary for me to emphasize again that the instantaneous discoidal disintegration of muscle fibres had been described long before I was able to confirm its occurrence. It has also been recently observed *in vivo*, and recorded cine-photomicrographically by Speidel as a "progressive transformation of single sarcomeres into discrete thin clots". As Speidel points out: "a few seconds of electrical stimulation were sufficient to initiate the formation of an incipient clot". It should not, therefore, be impossible to check Thoma's statement that disintegration may begin "plötzlich in beinahe explosionsartiger Weise" by repeating both his and Speidel's experiments.

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Internal Waves and Upwelling of Oceanic Water from Mid-depths on to a Continental Shelf

In January 1947 at a time when the winter maximum for inorganic phosphate dissolved in the sea is usually reached, a series of observations was made in the western English Channel. In an area north of the coast of Brittany in water of 35·40–35·45‰ salinity, temperature about 1° C. higher than in the surrounding water and a zooplankton community typical of 'south-western' water[1], phosphate around 0·40 mgm.-atom/m.³ P was found. If,

as appears probable, this is typical of Atlantic surface water at midwinter, the 'Channel' (setosa)[1] water, characterized by the presence of the chætognath, *Sagitta setosa*, which has occupied the English Channel in the neighbourhood of Plymouth since 1930–31 and has similar maximum phosphate content (0·42–0·48 mgm.-atom/m.³ P), may well have been derived from it. We should, however, have to look elsewhere for the origin of the higher phosphate content (0·6–0·7 mgm.-atom) of the 'elegans' or 'western' water[1] of the Celtic Sea, which in the nineteen twenties also filled the western end of the English Channel. The most probable source is upwelling of deeper ocean water from the continental slope. Such upwelling may be attributed to off-shore winds, which would need to be from the north and east. South-westerlies are the prevailing winds of the area both in direction and strength, and the winds from the northern and eastern sectors would, in general, seem not to blow hard enough or long enough to produce upwelling on the scale required. Periods of prolonged fresh easterly winds such as February 1947 are rather exceptional.

There is another possible mechanism by which nutrients could be brought from the deeper waters on to the continental shelf. The existence of internal or boundary waves in the ocean with an amplitude up to 100 metres is now well established. If such waves should impinge at right angles to a vertical cliff, no doubt they would be totally reflected. The continental slope, though steep, is far from vertical, so that the energy of an impinging wave must be dissipated in some other way. Most probably such a wave would run up the slope much as a surface wave runs up a shelving beach. In this way nutrient-richer water at mid-depths could be brought higher on to the shelf, where normal vertical mixing due to wind-waves and surface winter cooling would complete the process of bringing the richer water to the surface.

No evidence has yet been adduced to show whether or not submarine valleys or canyons such as those found on the New England coast are present along the continental slope west of the English Channel. If such exist, they would concentrate the energy of the internal wave into a contracting cross-section and greatly amplify the power of an internal wave to project deeper water into the surface layers. For a full understanding of the fertility of the sea in this area, a synoptic survey of the internal waves in the Atlantic abreast of the slope and a knowledge of the topography of the slope itself is therefore called for.

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March 5.

[1] Russell, F. S., *Cons. Perm. Int. Expl. Mer, Rapp. Proc.-verb.*, **100**, 7 (1936); *J. Mar. Biol. Assoc.*, **20**, 309 (1935).

Relative Directions of the Electric and Magnetic Vectors in Electromagnetic Waves *in vacuo*

Are the electric vector ($\vec{E}$) and the magnetic vector ($\vec{B}$) in electromagnetic waves *in vacuo* always mutually perpendicular, or are they not always so?

I put this question to a number of distinguished physicists, and all of them, without exception, answered definitely in the affirmative at first—and then agreed with me that the correct answer should be in the negative.

It follows from the Maxwell equations

$$\dot{\vec{E}} = c \operatorname{curl} \vec{B} \qquad \dot{\vec{B}} = -c \operatorname{curl} \vec{E}$$

that the time derivative vector of $\vec{E}$—not the vector itself—is perpendicular to $\vec{B}$ and, correspondingly, the time derivative vector of $\vec{B}$—not the vector itself—is perpendicular to $\vec{E}$. But the directions of the vector and of its time derivative always coincide only in the case of a non-rotating vector. This is, however, as a rule, not so in the case of a rotating vector (take, for example, the acceleration and the velocity in curvilinear motion).

Thus, in plane polarized plane electromagnetic waves, where the vectors $\vec{E}$ and $\vec{B}$ do not rotate, they are mutually perpendicular; but in rotating electromagnetic waves[1] and in electromagnetic whirls[2], where these vectors rotate, they are, generally speaking, *not* mutually perpendicular. Only in some exceptional cases are $\vec{E}$ and $\vec{B}$ perpendicular, in spite of rotation. This happens, for example, in circularly polarized plane waves, where both vectors are coplanar and rotate with equal angular velocity always at right angles to each other; and in spherical or in cylindrical waves, where one of the vectors rotates in an axial plane, while the other vector remains in the same position in an angular plane[1,2,3].

Apparently this point is usually overlooked, because until quite recently very little attention was given to the study of electromagnetic waves with rotating vectors other than plane and spherical waves.

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Feb. 15.

[1] *Phil. Mag.*, **19**, 934 (1935).
[2] *Phil. Mag.*, **20**, 417 (1935).
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Origin of Solar 'Static'

Recently, Martyn[1] wrote: "It is natural first to seek an explanation [of the origin of solar static] in terms of the kind of electrical discharge which causes the familiar terrestrial radio noise, namely, lightning flashes; but it is difficult, if not impossible, to see how such discharges could be produced in the always highly ionized solar envelope". The explanation to which Martyn raises objection is, in fact, one which I have myself put forward recently[2]. His objection, however, does not arise on the general theory which I have advanced elsewhere[3]. Far from preventing the existence of electric fields at the sun's surface, the thermal conditions there are themselves the result of electrical discharges. These discharges occur in the radial electric field set up by the emission of highly charged atoms from nuclear reactions in the sun's interior.

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Feb. 26.

[1] Martyn, D. F., *Nature*, **159**, 27 (1947).
[2] Bruce, C. E. R., *Observatory*, **66**, 263 (1946).
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CHEMISTRY OF THE PROTEINS

A DISCUSSION meeting on the "Chemistry of the Proteins" was held by the Chemical Society in the University of Bristol on February 13. Prof. J. L. Simonsen was in the chair, in the absence, through illness, of the president, Prof. C. N. Hinshelwood. The following papers were submitted: (1) "The Integration of Physical Methods in the Elucidation of Protein Structure", by Prof. J. D. Bernal; (2) "Modern Methods of Amino-Acid Analysis", by Dr. G. R. Tristram; (3) "The Degradation of Proteins by Proteolytic Enzymes", by Dr. J. A. V. Butler; (4) "Some Physico-Chemical Aspects of Plasma Proteins", by Dr. R. A. Kekwick.

Prof. Bernal outlined the physical methods by which information on the size, shape and crystal structure of the intact protein may be obtained. The ultra-centrifuge, with which Svedberg made the first great advance in the investigation of the gross structure of proteins, has now been shown to have certain fundamental limitations. As a method of estimating absolute molecular weights, it has probably an accuracy of 20 per cent, but it still provides accurate comparative data in investigations involving the fractionation of proteins. The electrophoresis technique introduced by Tisélius is also of great value in comparative studies, but it can do no more than separate out the different groups of proteins. Information on the shape of the protein particle has been obtained by sedimentation, viscosity and anomalous viscosity measurements and flow birefringence.

In reviewing the whole field Prof. Bernal stated that X-rays provide the most accurate means of investigating the gross architecture of the protein crystals. Perutz and Crowfoot have demonstrated how X-ray technique may best be applied, and their work has provided much information on the crystal structure of hæmoglobin and insulin respectively. The usefulness of the technique would be extended when it became possible to carry out measurements on the protein crystal in solution.

The electron microscope is a new instrument, now in the process of development; its resolving power is now about 10 A., and in the near future a resolving power of 5 A. may be expected. Already many remarkable results have been obtained, and the instrument may prove to be one of the most powerful means of examining the structure of proteins.

In conclusion, Prof. Bernal suggested that the time has now come when the efforts of the various branches of protein research should be co-ordinated.

Dr. G. R. Tristram next outlined the means which are now available for the investigation of the amino-acid composition of proteins. Prior to 1939, most of the methods were gravimetric, required upwards of 10 gm. of protein for each analysis and yielded results upon which little reliance could be placed. In recent years, there has been a rapid development of methods, based upon many novel principles, which require very small amounts (10–100 mgm.) of protein. Among the more important of these methods are: electrodialysis for the estimation of the basic amino-acids; partition chromatography for the estimation of certain of the mono-amino-acids; specific decarboxylases; isotope dilution and microbiological assay. Microbiological assay, which has undergone tremendous development in the United States, and isotope dilution are capable of application to the whole range of amino-acids, although it is impossible to assess their real value because much of the work on the microbiological technique has been uncritical, and so far isotope dilution has not been widely used.

The assessment of the accuracy of any method of analysis is handicapped by the impossibility of carrying out *bona fide* control experiments. It is therefore suggested that each method should (i) be capable of giving reproducible recoveries when tested on *ad hoc* mixtures of amino-acids; (ii) that the values obtained should be reproducible; and (iii) should be capable of duplication by independent methods.

A special technique has recently been developed by Sanger which makes it possible to characterize and estimate the amino-acids which provide the terminal NH_2 group(s) of the inact protein. Using this technique, much interesting information has been obtained by Sanger and his co-workers.

Insulin has now been analysed by Chibnall and his co-workers, and their chemical data suggest that the 'submolecule' has a molecular weight of about 12,000 and contains about 106 residues (102 of which have been characterized by analysis). The work of Sanger reveals that each 'submolecule' has four chains, the terminal amino-groups of which are two residues each of glycine and phenylalanine.

The development and uses of paper chromatography were outlined by Dr. A. H. Gordon. This qualitative technique makes possible the micro-detection and characterization of amino-acids and peptides. It has been used by Martin and Synge and their co-workers in their work on the structure of gramicidin-S.

Dr. J. A. V. Butler suggested that another method of approach to the determination of protein structure is by partial enzymatic hydrolysis. The products of hydrolysis should have molecular weights of about 1,000. Experiments have been carried out on the action of chymotrypsin and pepsin on insulin. The initial action of chymotrypsin is to hydrolyse off about eight peptide fractions, molecular weight *c.* 700, leaving a fairly massive core having a mean molecular weight of about 5,000. The latter is still precipitable by trichloracetic acid and is therefore easily separated. It contains the greater part of the cystine. Pepsin, on the other hand, breaks the molecule into fragments having a mean molecular weight of about 3,000.

It was observed many years ago that when peptic digests of insulin and other proteins are concentrated and treated with more pepsin at *p*H4, substances, insoluble in trichloracetic acid, the so-called 'plasteins', are formed. This was thought to be due to a resynthesis of peptide bonds. It has now been found that insoluble material is formed when peptic digests are incubated at various hydrogen ion concentrations, even when pepsin has been inactivated. It is suggested that some of the original peptic fragments still retain much of the order of the original protein and, when heated and treated in other ways, undergo changes similar to those which occur in protein denaturation, giving rise to an insoluble product.

Dr. R. A. Kekwick outlined methods of protein preparation with special reference to the plasma proteins. Although it is possible to isolate proteins by electrophoresis, the amounts obtained are necessarily limited. The method is of great value, however, for the control of fractionation procedures.

The solubility of a protein in aqueous solution depends upon *p*H, salt concentration, temperature and total protein concentration. Cohn studied the fractionation of plasma proteins with ethanol and established that, provided the temperature is maintained between 0° and −10° C., a further variable, the reduction of protein solubility by means of solvents, may be introduced with great advantage.

In the past, the application of electrophoresis and the ultra-centrifuge have been the main criteria for the purity of protein preparations. As Prof. Bernal pointed out, these methods are not adequate for the assessment of absolute purity. It is now generally agreed that the final test for purity of any protein should be the estimation of solubility, that is, the solubility should be independent of the amount of protein present in the solid phase.

THE MATHEMATICAL ASSOCIATION

ANNUAL MEETING

A GENERAL meeting of the Mathematical Association was held at the Polytechnic, Regent Street, W.1, during April 9 and 10, under the presidency of Mr. W. F. Bushell, head-master of Birkenhead School.

Mr. Bushell covered a wide field in his presidential address, "A Century of School Mathematics", giving a comprehensive and detailed account of the changes which have revolutionized the teaching of school mathematics in England during this period. The general level of mathematical teaching in mid-Victorian times was described by means of much instructive and entertaining material drawn from the two famous inquiries commonly known as the Clarendon Commission and the Endowed Schools Commission. By 1871, the sterility of a dull routine of a little arithmetic, algebra and Euclid, with no attempt to relate these topics to everyday life, was generally recognized by teachers; but the Association for the Reform of Geometrical Teaching (now the Mathematical Association), founded by Levett (King Edward School, Birmingham) and J. M. Wilson (then of Rugby, later head-master of Clifton and canon of Worcester), struggled for many years with the inertia of the older universities, the influence of which on the school curriculum through examinations was preponderating. The work of the Association did not begin to show real fruit until the early years of the present century; but since then, steady progress has been made towards an understanding of the proper place of mathematics in the schools and towards a mode of teaching which shall recognize the dual aspect of mathematics, as a high exercise in abstract thinking, and as a basic human element in the life of the ordinary citizen. Mr. Bushell noted that turning-points in the teaching of mathematics had occurred simultaneously with wars and crises in world affairs, the foundation of the Association for the Reform of Geometrical Teaching in 1871, the Balfour Act of 1903, and the Fisher Act of 1917; and he drew from this the hope that the Butler Act of 1944 would afford teachers of mathematics an opportunity for still further reforming progress.

During the afternoon of April 9, a demonstration and discussion on "The Place of Visual Aids in the Teaching of Mathematics" was held. Mr. I. R. Vesselo showed a number of films and film strips, suggesting possible uses for such visual aids in ordinary class teaching, and Mr. G. Patrick Meredith described a general theory of 'graphics' underlying the use of such material. The discussion seemed to show that the majority of teachers are not convinced that the film material as yet available in mathematics is sufficiently helpful to allow it to replace blackboard and chalk. In connexion with the discussion, Mr. Vesselo had arranged a very comprehensive exhibition of visual aids, which was open during the two days of the meeting. Models, wall charts, pictures, diagrams, all bearing on the teaching of school mathematics, had been collected in large numbers, and showed how much can be done with simple and inexpensive materials.

Later, Prof. H. Davenport (University College, London) gave a paper on "The Geometry of Numbers", in which he described in extremely lucid and simple fashion the way in which Diophantine problems in the theory of numbers can be solved by the application of geometrical concepts, a method due in the first place to Minkowski, and since then used and developed by many workers in this field.

The proceedings on April 10 opened with a paper from Mr. B. C. Brookes (Bedford) on "The Incorporation of Statistics into a School Course". The general opinion of teachers is in favour of such incorporation; but there are difficulties which have often proved insuperable, due, for example, to the influence of external examinations on the school curriculum. Mr. Brookes dealt with the place of statistics in a 'sixth form' curriculum and also in the general mathematical course in a school, and paid attention to the necessary detail of content, method and balance between theory and application. Members were much impressed by the sound practical suggestions put forward in this paper.

Dr. R. L. Goodstein (University of Reading) spoke on "Proof by *reductio ad absurdum*". He analysed the formal logic underlying such proofs, showing how they depend essentially on the logical 'law of contradiction' and 'law of the excluded middle', and by means of an example exhibited the difficulties and paradoxes which may arise. Again, by means of three simple examples he showed that a direct proof may often be not only as simple as an indirect proof, but may in general be expected to yield more precise information. He referred briefly to recent work on logic by Post and Lukasiewicz, in which many-valued logical systems are elaborated; in such systems the two values 'true' and 'false' of a proposition are replaced by three or more.

A discussion took place on April 10 on "A Unified Course in Mathematics in Secondary Schools", being in some sense a sequel to last year's discussion on mathematics in the 'modern' school. The discussion was opened by Mr. A. W. Riley (Wolverhampton), Mr. K. S. Snell (Harrow) and Miss E. Barnes (Birmingham). All three of the opening speakers stressed the need for seeing the school course in mathematics from the point of view of the child, rather than considering it as a mental discipline imposed on the child from above. All agreed that in the early stages the child's knowledge must grow out of his (or her) own needs and increasing awareness of the external world. For this purpose, mathematics should be presented not as a set of disconnected water-tight compartments labelled 'arithmetic', 'algebra', etc., but as a growing body of knowledge which will be

arithmetical, algebraical, geometrical or trigonometrical in turn as occasion demands. The growth of such knowledge was compared to that of a tree, with a main trunk from which in due time various branches will spring, not all at the same time, nor all growing at the same rate. Mr. Riley discussed the whole field, and made specific suggestions for the details of a unified course; Mr. Snell dealt with the earlier part of the secondary course, and Miss Barnes with the later part, referring specially to her own work in a girls' school. In the open discussion, Mr. C. V. Durell stressed the importance of equipping the child with the mathematical tools which he will need for life in the modern world, and the equal importance of training the child to select the mathematical tool appropriate to a particular task. The discussion was vigorous and keen; the need for suitable text-books was mentioned, but many members agreed with Mr. G. L. Parsons (Merchant Taylors') in his insistence that if a clear objective is, first and foremost, envisaged by the child, and then by the teacher, the text-book problem is but a small matter.

The final paper of the meeting was by Mr. P. F. Burns, on "Astronomy in the Schools". Mr. Burns spoke as an enthusiast, but he wasted no time on abstract arguments; he went straight to the point by showing how much can be done with children whose mathematical knowledge is very small. On the minimum—a surprisingly small one—of such knowledge, he showed how children in two schools on the same meridian, one in Lancashire and one in Gloucestershire, had made and combined observations so as to be able to deduce the length of the circumference of the earth. By ingenious cutting and folding of simple diagrams, with a little elementary geometrical drawing, he showed a method for determining the great circle distance between two points on the earth's surface.

The president of the Association for the forthcoming year is Prof. G. B. Jeffery, principal of the Institute of Education, University of London.

"THE BEGINNING OR THE END?"

THE much-heralded film "The Beginning or the End?" (Metro-Goldwyn-Mayer) was shown privately to a distinguished audience in the Palace Theatre, London, on April 22. Judged by any standard or from any point of view, it is not a good film. Generally, it is dull—a cardinal sin in a film meant for the commercial cinema. From the documentary point of view it is disappointing, since it really tells so little about all the atomic research which led eventually to the release of atomic energy; in fact, it confines itself solely to that comparatively short time devoted to the development of the atomic bomb in the United States. This will assuredly lead the non-scientists into believing that most atomic energy research has been American. Apart from three less well-known British atomic scientists who, according to the film, represented the British contribution ordered to America by Mr. Winston Churchill, the characters are all American. (It is stated that Fermi worked in his native Italy until 1939.)

Towards the beginning of the film, lip-service was paid to the contributions of such geniuses as Rutherford, Joliot, Chadwick, Hahn and a few others, in one or two sentences uttered from his arm-chair by an actor representing Einstein, but whose elocution was so poor that even this small concession will be lost on a lay audience. Meitner, Oliphant, Blackett, Cockcroft, Bohr and other important persons were not mentioned at all. On the other hand, Oppenheimer, Fermi, Vannevar Bush, Urey, Conant, Szilard, Compton and Lawrence were all represented in the plot, though with the exception of Fermi and Szilard, none figured very largely.

It is true that the film confined itself to the development of the atomic bomb, and we know that most of that work took place in the United States. In view of this, it would have been better if the entire film had been produced as a documentary. But if the world is to realize the importance of atomic energy research and its effect for good or ill on man and his future it would have been best not to lift this section of an almost world-wide and long-drawn-out team work from its context. A more faithful, comprehensive and revealing study of the science of the atom is necessary if the commercial cinema is to continue its excellent contributions to adult education, to which we have frequently referred. Perhaps in due, course, Metro-Goldwyn-Mayer or the J. Arthur Rank Organisation will consider presenting to the public the whole romance of atomic research, going back even as far as Dalton and reaching as a climax not only the release of atomic energy in the form of a bomb but also a few prophetic shots of what atomic energy could do for power production, medical research, etc. Then we may be sure that such scientific worthies as Thomson, Curie and Rutherford will be revealed as important contributors to what is really one project.

A 'brains trust' followed the showing of the film—not to discuss and criticize the film but to answer questions of human interest in connexion with atomic energy. Its personnel comprised Royal Air Force and Royal Navy observers at the actual bomb explosions, two politicians, an actor and author and Dr. C. E. M. Joad. It will be noted that science itself was not represented on this 'trust' in spite of the fact that the omission was pointed out to the organisers in plenty of time for it to be rectified. This is to be deplored, especially in view of the fact that several atomic physicists of international fame are within comparatively easy reach. It is to be hoped that we may not look upon this choice as indicative of the attitude of the intelligent public to present-day science.

One important function this film might have is to bring home to every man and woman who sees it a deeper sense of urgency which seems to be lacking, especially in Britain. A copy of the film was buried with due solemnity beneath the giant redwoods of California, to be disinterred five hundred years hence. If anyone exists then, we doubt whether he will learn anything that he has not already learned from more authoritative sources, especially the publications of the men of science themselves.

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, April 28

CHEMICAL SOCIETY (in the Chemistry Lecture Theatre, King's College, Newcastle-upon-Tyne), at 5 p.m.—Scientific Papers.

INSTITUTION OF POST OFFICE ELECTRICAL ENGINEERS (at Faraday Building, 9th Floor, South Block, Knightrider Street, London, E.C.4), at 5 p.m.—Mr. K. W. Hix: "Repeater Station Power Supplies".

INSTITUTION OF ELECTRICAL ENGINEERS (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Discussion on "Domestic Water Heating by Electricity" (to be opened by Mr. R. Grierson and Mr. Forbes Jackson).

INSTITUTION OF THE RUBBER INDUSTRY, MANCHESTER SECTION (at the Engineers' Club, Albert Square, Manchester).—Annual General Meeting.

Tuesday, April 29

UNIVERSITY COLLEGE (at Gower Street, London, W.C.2), at 5.15 p.m.—Dr. M. H. Pirenne: "The Quantum Physics of Vision" (other lectures on May 6 and 13).•

ROYAL ANTHROPOLOGICAL INSTITUTE (at 21 Bedford Square, London, W.C.1), at 5.30 p.m.—Prof. F. E. Zeuner: "Climate and Early Man in East Africa".

ROYAL PHOTOGRAPHIC SOCIETY, SCIENTIFIC AND TECHNICAL GROUP (at 16 Princes Gate, London, S.W.7), at 7 p.m.—Dr. E. E. Loening: "The Latent Image in the Test Tube".

SHEFFIELD METALLURGICAL ASSOCIATION (at 196 West Street, Sheffield), at 7 p.m.—Mr. Brinley Jones: "Springs for High Duty Purposes".

SOCIETY OF INSTRUMENT TECHNOLOGY (at the Royal Society of Tropical Medicine and Hygiene, Manson House, 26 Portland Place, London, W.1), at 7 p.m.—Mr. J. A. Hall: "Molten Metal Temperature Measurement".

Wednesday, April 30

BOTANICAL SOCIETY and EXCHANGE CLUB OF THE BRITISH ISLES (at the Linnean Society, Burlington House, Piccadilly, London, W.1), at 2.30 p.m.—Annual General Meeting.

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 5 p.m.—Mr. E. J. B. Lloyd: "Economic Reconstruction, 7, Distribution".

CHALLENGER SOCIETY (at the Zoological Society, Regent's Park, London, N.W.8), at 5.45 p.m.—Dr. Anton Fr. Bruun: "The *Atlantide* Expedition to the West African Coast".

INSTITUTE OF WELDING (joint meeting with the INSTITUTE OF METALS, at the Institution of Civil Engineers, Great George Street, London, S.W.1), at 6 p.m.—Dr. Maurice Cook and Mr. Edwin Davis: "The Welding of Copper and the Copper-Rich Alloys".

Thursday, May 1

INSTITUTION OF MECHANICAL ENGINEERS, GRADUATES' SECTION (at Storey's Gate, St. James's Park, London, S.W.1), at 6.30 p.m.—Annual General Meeting. Mr. E. A. Ritchie: "Statistical Quality Control".

CHEMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 7.30 p.m.—Scientific Papers.

Friday, May 2

CHEMICAL SOCIETY, EXETER BRANCH (in the Washington Singer Laboratories, The University, Bristol), at 4.30 p.m.—Prof. M. Stacey: "Advances in Immunochemistry".

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS, PHYSICAL METHODS GROUP (in the Chemistry Lecture Theatre, King's College, Newcastle-upon-Tyne), at 6 p.m.—Papers on "Physical Methods of Gas Analysis".

SOCIETY OF DYERS AND COLOURISTS (at the Royal Technical College, Glasgow), at 7.30 p.m.—Mr. E. J. Bowen, F.R.S.: "Colour and Constitution—Absorption of Light by Chemical Compounds" (Fourth Mercer Lecture).•

Saturday, May 3

BRITISH INTERPLANETARY SOCIETY (at St. Martin's Technical School, Charing Cross Road, London, W.C.2), at 6 p.m.—Mr. M. W. Ovenden: "The Nature and Distribution of Meteors".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

GRADUATE ASSISTANT TEACHER OF MECHANICAL ENGINEERING SUBJECTS—The Principal, Twickenham Technical College, Egerton Road, Twickenham, Middx. (May 3).

TEACHER OF MECHANICAL ENGINEERING SUBJECTS—The Principal, Acton Technical College, High Street, Acton, London, W.3 (May 3).

LECTURER IN THE DEPARTMENT OF CHEMISTRY AND APPLIED CHEMISTRY—The Principal, Royal Technical College, Peel Park, Salford 5 (May 3).

TEACHER OF MECHANICAL ENGINEERING SUBJECTS—The Principal, Hendon Technical College, The Burroughs, Hendon, London, N.W.4 (May 3).

LECTURER IN MATHEMATICS—The Clerk to the Governors, Woolwich Polytechnic, Woolwich, London, S.E.18 (May 3).

ASSISTANT LECTURER (well-qualified graduate) to teach MECHANICAL ENGINEERING up to Higher National Certificate standard, and an ASSISTANT LECTURER to teach GENERAL MECHANICAL ENGINEERING to at least the Ordinary National Certificate, in the York Technical College—The Chief Education Officer, Education Offices, 5 St. Leonard's, York (May 3).

DIRECTOR OF PHYSICAL RESEARCH in the Admiralty—The Secretary, Civil Service Commission, 6 Burlington Gardens, London, W.1 quoting No. 1853 (May 8).

SCIENTIFIC ASSISTANT (temporary) IN THE DEPARTMENT OF ZOOLOGY for research on fertility in mammals—The Secretary and Registrar, University College of North Wales, Bangor (May 8).

LECTURER IN GEOPHYSICS—The Professor of Physics, Imperial College of Science and Technology, South Kensington, London, S.W.7 (May 10).

RESEARCH OFFICER (Fuel Chemist), DIVISION OF AERONAUTICS, Melbourne—The Secretary, Australian Scientific Research Liaison Office, Australia House, Strand, London, W.C.2, quoting No. 967 (May 12).

SENIOR RESEARCH OFFICER or RESEARCH OFFICER (male), TIMBER MECHANICS SECTION, Division of Forest Products, Melbourne—The Secretary, Australian Scientific Liaison Office, Australia House, Strand, London, W.C.2, quoting No. 999 (May 12).

RESEARCH OFFICER (Theoretical Physics), DIVISION OF INDUSTRIAL CHEMISTRY, Melbourne—The Secretary, Australian Scientific Liaison Office, Australia House, Strand, London, W.C.2, quoting No. 1004 (May 12).

LECTURER IN PHYSICS (up to B.Sc. Special standard), preferably with subsidiary mathematics and chemistry, a SENIOR ASSISTANT IN BIOCHEMISTRY or BIOLOGY, a RESPONSIBLE LECTURER IN MECHANICAL ENGINEERING (up to Final B.Sc. standard), a LECTURER IN MECHANICAL ENGINEERING, and a SENIOR ASSISTANT IN CIVIL ENGINEERING—The Registrar, Nottingham Technical College, Shakespeare Street, Nottingham (May 12).

SENIOR RESEARCH OFFICER (X-Ray Crystallography), IN THE DIVISION OF INDUSTRIAL CHEMISTRY, Melbourne—The Secretary, Australian Scientific Liaison Office, Australia House, Strand, London, W.C.2, quoting No. 1032 (May 12).

RESEARCH OFFICER (Wood Chemistry Section), DIVISION OF FOREST PRODUCTS, Melbourne—The Secretary, Australian Scientific Liaison Office, Australia House, Strand, London, W.C.2, quoting No. 1230 (May 12).

CHAIR OF MINING, and the CHAIR OF INDUSTRIAL RELATIONS—The Registrar, University College, Cathays Park, Cardiff (May 15).

PRINCIPAL SCIENTIFIC OFFICER at the Telecommunications Research Establishment of the Ministry of Supply at Malvern, Worcs.—The Secretary, Civil Service Commission, 6 Burlington Gardens, London, W.1, quoting No. 1856 (May 15).

SUPERINTENDENT (Projects and Planning) at the Royal Aircraft Establishment of the Ministry of Supply—The Secretary, Civil Service Commission, 6 Burlington Gardens, London, W.1, quoting No. 1867 (May 15).

LECTURERS (2) IN PHYSICS—The Registrar, The University, Glasgow (May 15).

NUFFIELD FELLOWSHIPS (3) for experimental and theoretical research in Nuclear Physics, and TECHNICAL ASSISTANTS (2) in research work in Atomic Physics—The Professor of Natural Philosophy, The University, Glasgow (May 15).

ASSISTANT LECTURER or LECTURER, and a LECTURER or SENIOR LECTURER, IN THE DEPARTMENT OF BIOCHEMISTRY—The Registrar, The University, Sheffield (May 17).

ASSISTANT KEEPER (Class II)—The Keeper and Secretary, London Museum, St. James's, London, S.W.1 (May 17).

LECTURER or ASSISTANT LECTURER IN CIVIL ENGINEERING, and a LECTURER or ASSISTANT LECTURER IN GEOLOGY—The Secretary, King's College, Strand, London, W.C.2 (May 17).

ASSISTANT LECTURER (Grade III) IN PSYCHOLOGY, and an ASSISTANT LECTURER (Grade III) IN CHEMISTRY—The Secretary and Registrar, The University, Bristol (May 19).

LECTURER IN PHYSIOLOGY—The Registrar, The University, Leeds 2 (May 19).

ASSISTANT LECTURERS (2, Grade III) IN MATHEMATICS, and an ASSISTANT LECTURER (Grade III) IN CHEMISTRY—The Secretary and Registrar, The University, Bristol (May 19).

READERSHIP IN AGRICULTURAL ECONOMICS tenable at the London School of Economics and Political Science—The Academic Registrar, University of London, Senate House, London, W.C.1 (May 22).

SENIOR PRINCIPAL SCIENTIFIC OFFICER (to take charge of research and other work on precise engineering measurements) at the National Physical Laboratory—The Secretary, Civil Service Commission, 6 Burlington Gardens, London, W.1, quoting No. 1859 (May 22).

PRINCIPAL SCIENTIFIC OFFICER (to take charge of a team of workers on the application of X-ray diffraction, etc., to the study of metals and other crystalline substances) at the National Physical Laboratory—The Secretary, Civil Service Commission, 6 Burlington Gardens, London, W.1, quoting No. 1860 (May 22).

CHIEF OF THE DIVISION OF WOOL TECHNOLOGY, Geelong, Victoria—The Secretary, Australian Scientific Research Liaison Office, Australia House, Strand, London, W.C.2 (May 24).

LECTURER or SENIOR LECTURER IN ELECTRO-TECHNICS—The Registrar, The University, Manchester 13 (May 24).

CHAIR OF PSYCHOLOGY—The Registrar, The University, Sheffield (May 24).

RESEARCH OFFICERS (2), DIVISION OF INDUSTRIAL CHEMISTRY, Melbourne—(*a*, Reference No. 1253) to investigate bacterial carbohydrate metabolism in relation to industrial fermentation processes; (*b*, Reference No. 1254), to conduct investigations on proteins and the products of their hydrolysis by enzymes—The Secretary, Australian Scientific Research Liaison Office, Australia House, Strand, London, W.C.2, quoting the appropriate Reference No. (May 26).

ASSISTANT GOVERNMENT CHEMIST in Hongkong—The Director of Recruitment, Colonial Service, 15 Victoria Street, London, S.W.1 (May 26).

LECTURER IN BOTANY (excluding physiology and mycology) in the United College—The Secretary, The University, St. Andrews (May 30).

SENIOR ASSISTANT IN THE DEPARTMENT OF CIVIL AND MECHANICAL ENGINEERING, a SENIOR ASSISTANT IN THE DEPARTMENT OF CHEMISTRY, and a LECTURER IN CHEMISTRY—The Principal, Technical College, Queen Street South, Huddersfield.

LECTURER IN PHYSIOLOGY AND ZOOLOGY—The Registrar, Technical College, Sunderland.

RECTOR OF, and LECTURESHIPS IN, THE TEACHER TRAINING COLLEGE, Achimota, Gold Coast—The Secretary, Achimota Committee, Edinburgh House, 2 Eaton Gate, London, S.W.1.

SENIOR ASSISTANT LECTURER IN THE DEPARTMENT OF MECHANICAL ENGINEERING—The Principal, Borough Polytechnic, Borough Road, London, S.E.1.

SENIOR LECTURER (Senior Assistant) IN PHYSICS—The Principal, Sir John Cass Technical Institute, Jewry Street, London, E.C.3.

HEAD OF THE PHYSICS DEPARTMENT—The Clerk, Northern Polytechnic, Holloway, London, N.7.

SENIOR CHEMISTRY MASTER (to take Chemistry up to scholarship standard)—Headmaster, Loretto School, Musselburgh, Edinburgh.

LECTURERS (2) IN PHYSIOLOGY—The Dean of the Medical College, St. Bartholomew's Hospital, West Smithfield, London, E.C.1.

LABORATORY ASSISTANT with experience of food and/or biochemical analysis—Prof. Robertson, Royal (Dick) Veterinary College, Edinburgh 9.